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DEVELOPMENT OF THE OPEN DOOR POLICY IN CHINA

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Vol. XXXIV FEBRUARY, 1938 No. 2

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Development of the Open Door Policy in China

By K. S. INUI, LL.D.

(Based on a lecture delivered before The Institute of Political Science, at Sydney, November 25, 1936).

* * *

I—Background of the Open Door Policy

IT is often claimed that the Open Door Policy owes its inception to the Whampoa Treaty of 1842 between China and Great Britain, which provides for the most-favored-nation clause. No one can deny that the germ of equality of commercial opportunities, which is its cardinal principle, was securely imbedded in that clause. However, to say that that stipulation was the origin of the Open Door Policy in China is stretching a point. For, so far as the ideas of fairness and equality are concerned, we will have to go back to the Bible, religious and moral teachings of all countries, indeed, to human nature itself. Furthermore Great Britain, as the party of the first part, at the time, was ostensibly, at any rate, dealing directly with China, whom she then conceived to be a completely independent nation, as the party of the second part, which notion precludes the introduction of the phrase, or its equivalent, into a treaty.

According to one authority the first use of the phrase as meaning "free admission or access" seems to have been made about 1526, and its use in international economic politics dates back to 1856. The Open Door Policy as an international practice of securing or regulating economic opportunities is usually said to have originated in the Berlin Act of 1885. However, it was American Secretary of State Hay who used it in an official document relating to international economic activities in the Far East.

We are told of the important rôle Henry Morton Stanley played in this connection. The reader will recall that he was dispatched to locate David Livingstone, who was lost in Central Africa. Upon his return he announced an unclaimed Empire, and urged, at the Manchester Chamber of Commerce in 1884, that, if the African natives could be induced to wear clothes on Sundays only, Manchester would be able to dispose of 300,000,000 yards of goods, which argument has as yet by no means become out-of-date in many industrial countries. He impressed greatly the hard-headed Manchester businessmen, but not quite enough to put his proposal into action. He thereupon went to Brussels, and appealed to King Leopold II, who immediately organized "Comite d'etudes du Haut Congo." This soon brought about the creation of The Congo Free State. In the meantime Portugal proclaimed her sovereignty of the mouth of the Congo River in 1884. This was responsible for a British-Portuguese Convention in which the former was to recognize the latter's claim on condition that the former would grant the latter the most-favored-nation treatment, although this agreement was not finally ratified, for a reason that I am about to touch upon. Simultaneously French and German traders came to complain of Portugal's exclusive treatment of other nationals. This led to the Berlin Conference of 1885, which brought about the conclusion of a multilateral agreement known as the Berlin Act, embodied in "The Declaration Relative to Freedom of Trade in the Basin of the Congo, its Mouth and Circumjacent Region," with other provisions connected therewith. The Open Door Policy in the Far East is nothing but a transliteration of the Congo experience of the Powers in another dark corner of the world.

The Sino-Japanese war exposed the miserable weakness of China. Although Japan was victorious, she was not yet impressive enough to check the inevitable extension of the then prevailing international system of European balance of power or concert. The so-called triple interference of Russia, Germany and France, which compelled Japan to give up her rightful fruits of victory in Manchuria, is now well known as a conspicuous landmark of European diplomacy in the Far East. Highly elated over their diplomatic victory, these Powers one by one appropriated spheres of influence or concessions. In order to uphold the balance of power in that part of the world, even Great Britain was not to be left out. Italy also set out her claims, although she was unsuccessful.

To borrow a list, from Mr. K. K. Kawakami in his "Japan's Pacific Policy," of a few concessions, China was obliged to make since the Opium war of 1842 leading up to the introduction of the Hay Doctrine in 1899:

England takes Hongkong after the Opium War	1842
China Cedes Amursk to Russia	1858
China Cedes Maritime Province to Russia	1860
England obtains lease of Kaulung Peninsula, opposite Hongkong	1861
France annexes three provinces in Cochin China	1867
France takes Tonking and Annam	1885
England takes Burma	1886
France secures right to extend the Annam railway to China	1895
Japan receives Formosa	1895
Cassini Convention, by which Russia secures the right to build a railway through Manchuria	1895
England obtains lease of more territory on Kaulung Peninsula	1896
Franco-British agreement for equal participation in railway building in Yunnan and Szechuen	1896
Russia organizes a bank (Russo-China Bank) to secure control of China's economic resources, especially in Manchuria	1895
Russia rejects German participation in this bank	1895
Germany retaliates by seizing Kiaochow, which Russia had intended to lease—November	1897
Russia, through the dummy of a Belgian syndicate, secures concession to build the Peking-Hankow railway	1897
France secures concession for the Yunnan railway	1897
England declares the Yangtze Valley her sphere of influence—February	1898
France leases Kwangchow Bay	1898
German-Chinese Convention leasing Kiaochow to Germany—March	1898
Russo-Chinese Convention leasing Port Arthur and Dalny to Russia—March	1898
France declares South China her sphere of influence—April	1898
England, to make her position secure, recognizes the German sphere of influence in Shantung—April 18	1898
England leases Weihaiwei—July	1898
British-German agreement, recognizing England's Special position in Shantung and territory north of the Yellow River—September	1898

Italy demands in vain lease of Sammun Bay 1899
Scott-Muravieff agreement, by which Russia promises to confine her activities north of the Great Wall, recognizing British sphere of influence in the Yangtze Valley 1899
China grants to Russia the exclusive right to construct railways in Mongolia 1899

If we follow these events up-to-date, undoubtedly, Japan would figure prominently in the list. Suffice it to say, however, that these constitute the background for the Open Door Policy in China. One reference might be made here, that is, there is one vast difference between the ways, the several rights and concessions of various powers are now in their hands. They have all paid for them in blood and treasure. But Japan paid more than any other, even prior to 1899, while the United States paid virtually nothing except at the time of the Boxer trouble. Japan, furthermore, became heir of the two most conspicuous offenders of the Open Door Policy, against whom the doctrine was primarily directed. Hence she has inherited both the privileges as well as the scorn of these allegedly guilty parties of the Hay period. From that moment to this, the doctrine has gone through several stages of evolution.

II—The Evolution of the Open Door Policy

The First Stage.—By 1898 the United States of America was definitely assuming the rôle of a Pacific power, freshly defeating Spain, annexing the Sandwich Islands and the Philippines, ready to present and press her views in the affairs of the Far East. The declared American interest in the Far East was two-fold, Christian evangelism and commerce. Apprehensive of possible and remored partition of China into various spheres of influence, and conscious of his country's belated entrance into the trade advantages in the Far East, Secretary Hay, for the Expansionist Republican Cabinet of President William McKinley, issued timely and bold circular letters to the Powers interested in the Far East, which are now famous as Hay's Open Door Notes.

In these letters Mr. Hay's open door doctrine was defined as follows :—

(1) That no Power will in any way interfere with any treaty port or vested interest within any so-called "sphere of influence or interest" or leased territory it may have in China.
(2) That the Chinese treaty tariff of the time being shall apply to all merchandise landed or shipped to all such ports as are within said spheres of influence (unless they be free ports), no matter to what nationality it may belong, and that duties leviable shall be collected by the Chinese Government.
(3) That no power shall levy any higher harbor dues on vessels of another nationality frequenting any port in such sphere than shall be levied on vessels of its own nationality, or any higher railroad charges over lines built, controlled, or operated within its spheres on merchandise belonging to citizens or subjects of other nationalities transported through such sphere, than shall be levied on similar merchandise belonging to its own nationals transported over equal distances.

This may be called the introduction into, and the first stage of the Open Door doctrine in the Far East. Now what are some of its characteristics ?

(1) The Open Door Policy owes its origin to the fundamental idea of fairness and equality in the enjoyment of economic participation.
(2) Open Door is the desire or demand of a newcomer to the scene for equality in the enjoyment of economic opportunities, and it is to be distinguished from the most-favored-nation treatment, which is a guarantee against discrimination demanded by earlier arrivals.
(3) Its practice emanates in the improvisation by the superior or dominant parties over the backward or imperfectly sovereign state, in order that the strong may be assured of equality of economic opportunities with or without consultation, with or without the consent of the weak (though Japan at the conclusion of the Russo-Japanese war obtained the consent of China by Treaty to the transfer to her of the former Russian rights and interests in Manchuria).
(4) Hence it has been usually an engagement between the parties foreign to the sovereign authority of the area where the doctrine is supposed to operate. It naturally follows that the country or area covered by the Open Door engagement is not a party to the execution of the agreement. The obligations under the Open Door are between the superior parties, whereas in the case of the most-favored-nation treatment, the contracting parties keep themselves directly responsible in their own primary jurisdiction, where it operates. However, we shall see presently a modification of some of these points.
(5) The most-favored-nation treatment is usually bi-lateral (although there are some cases of only reciprocal or conditional application), and is rarely unilateral. However, the Open Door Policy is usually general in application among the parties participating in the area concerned, and cannot be bi-lateral or conditional from the very nature of the origin of the doctrine. However, whether China also may enjoy equal opportunities or not depends upon the nature and terms of leases or agreements over the area in question.
(6) Originally the subject matter of the most-favored-nation treatment related to purely economic matters, such as tariffs, tariff formalities, railway charges and the like, as was the case with earlier expectations of the Open Door Policy. However, as China is bound by Consular jurisdiction and extra-territorial rights, both the most-favored-nation treatment and the Open Door Policy began to find their widest applications. There are now those who claim that its application extends to matters relating to telephone, telegraph, mining, agriculture, investment, employment of advisers.
(7) Differences arose due to the nature of economic activities and to its interpretation, whether, for instance, it was monopolistic and too sweeping or antagonistic and injurious to existing interests.
(8) It is clear from the language used by Secretary Hay that the doctrine came into existence only because it recognized the vested interests or acquired rights of several Powers in China, and that these rights and interests were not to be interfered with.
(9) There are some who claim that the Open Door principle includes the maintenance of the integrity of China. But this is like begging the question. These two phrases are often closely strung together. But neither one is a part of the other. Each might be the corollary but not the condition of the other. The very existence envisages China's delinquency over parts of her own claimed jurisdiction or else that in such an area or sphere she is not exercising her complete sovereign integrity.

This leads to the next point, that with the march of events in the Far East, especially of China herself, evolution of the doctrine is to be expected.

The Second Stage.—Splendid as this doctrine, newly transplanted into the semi-colonial atmosphere from the colonial clime of Africa, was, it met even a worse fate in the new environment than it did in its original habitat. For that part of Africa was a non-entity in the eyes of the interested Powers. But in the Far East, China had a proud background of tradition and civilization. Her people are past masters in the art of diplomacy, of balance of power, and of controlling one barbarian by another. The unsuspecting and confident European nations came to the Far East fully equipped with their training, only to meet their equals in these arts. A steady balance was not to be expected, especially with the shifting China as the support in the middle.

The World War came. The relative importance of the weights that balanced the scale underwent considerable changes. China as a participant in the World War by sending 100,000 coolie laborers for auxiliary work, raised her voice, and found ready supporters. A new balance had to be worked out or else new machinery improvised. The League of Nations came into existence to remedy similar conditions then obtaining throughout the world, with the possible exception of the Western Hemisphere, whose spokesman was the author of the new international instrument for peace by universal participation. But he could not persuade his own country to budge an inch toward what war-torn Europe considered, the new hope of the world. Conscious of its failure to join the

League and yet anxious to contribute to the consolidation of the peace of the Far East, President Harding proposed the Washington Conference for the Limitation of Armaments and discussion of Pacific and Far Eastern questions.

A discussion of the political and psychological aspects of the Conference may be of great interest. But suffice it to say that the Washington Nine Power Treaty was thus brought into being in order to meet the new situation in the new East. The first article, provides the following :

> The Contracting Parties, other than China, agree :—
> (1) To respect the sovereignty, the independence and the territorial and administrative integrity of China ;
> (2) To provide the fullest and most unembarrassed opportunity to China to develop and maintain for herself an effective and stable government ;
> (3) To use their influence for the purpose of effectually establishing and maintaining the principle of equal opportunity for the commerce and industry of all nations throughout the territory of China ;
> (4) To refrain from taking advantage of conditions in China in order to seek special rights or privileges which would abridge the rights of subjects or citizens of friendly states, and from countenancing action inimical to the security of such states.
>
> Paragraphs 1 and 2 afford most fertile grounds for discussions on sovereignty, defense and aggression. But in the present theme we are more interested in the development of the subject matter embodied in Paragraphs 3 and 4.

Although " The Contracting Powers, other than China, agree, etc." is repeatedly used, in accordance with earlier understanding and practice, China, for the first time in 1922, definitely commits herself in Article V not to " exercise or permit unfair discrimination of any kind through the whole of the railways in China," in addition to the fact that she is one of the nine signatory Powers to the Treaty. Thus the second stage in the development of the Open Door Doctrine was ushered in.

Under the Hay Doctrine China was not legally bound by the engagement, while under the Nine Power Treaty :

(1) The question no longer was the matter of the Powers alone ; China herself became a party to the international document and began to play an important part in the Open Door drama of the Far East.
(2) The Washington Agreement called for the registration of all agreements between China and Powers, pursuant to the spirit of open diplomacy. Thus international obligations doubly became the concern of the parties, including China.
(3) As in the Hay Doctrine, the Nine-Power Treaty to which China is a party recognized the vested interests and acquired rights of others.
(4) While under the Hay Doctrine the Contracting Parties, not including China, were the dominant interpreters and executors of their respective commitments, who in turn were to assume the stipulated or expected responsibilities, the Nine Power Treaty set up machinery for difficult problems arising out of the operation of the principle.
(5) And a Board of Reference was to be newly created as a result of the agreement, to which were to be referred, any questions arising in connection with the execution of the matters envisaged by the Nine Power Treaty, for investigation and report.
(6) As exemplified by the fact that China was charged with the duty of calling a conference for the formulation of the Board, her rôle was expected to be active and positive.

For the few years following the Washington Conference the contracting parties were animated by the Geneva and Washington spirit. Many thought that a new era in Oriental affairs was assured. Kiaochow and Weihaiwei were returned to China by Japan and Great Britain respectively, without much ado. However, a reciprocal gesture of co-operation on the part of China was not forthcoming. On the contrary, China passively objected to the creation of the Board of Reference as an infringement of her prerogative. She was utterly incapable of taking any " immediate effective steps " to reduce " military forces and expenditure," which action was called for by a Washington resolution. We can go on to enumerate these examples of China's failures to meet the Washington expectations. But why charge her alone, as they were the reflections of the Powers' inability to fathom the realities in China.

Japan's rise as a nation acted as a leaven in infusing new inspiration into a disjointed China. This was rekindled by the Wilsonian theme of self-determination of peoples. The Russian revolutionary diplomacy of disregarding international obligations was impressive but not a wholesome precedent to Young China, groaning under the yoke of what appears to them an endless series of unilateral treaties.

Because the Open Door embodies the elements of fairness and equality of economic opportunities, it was considered among nations as a highly desirable and commendable policy and practice. But it must be remembered that the Open Door envisages as we have seen the existence of a regime of imperfect control. It is for this reason that there are many Chinese scholars who are strongly opposed to its continuation. However, it has been tolerated by China because the Nine Power agreement contained a twin phrase to the Open Door Policy, namely, a clause respecting " the integrity of China." But the very fact of the Open Door Clause is a proof of the existence of an area of semi-colonial status over which full sovereignty is not functioning, and the integrity to be preserved is already, partially at any rate, impaired. Whatever may be said of the Manchu regime, with the exception of certain areas including leases and spheres of influence, they exercised a reasonable amount of authority over the territory of China.

With her growing resentment of any suggestion of imperfect control of her territory, and the stigma attached thereto, China is likely to be the first country to disapprove the continued existence of the Hay or Washington type of Open Door doctrine. What is to take its place spells the third development of this phrase in Asia.

The Third Stage.—We have already hinted that the temporary growth of the idea of liberalism and equality of opportunities is a result of the Washington Conference, with a parallel development of identical principles in League of Nations circles. It is only natural that the Mandate Clauses of the Covenant are permeated by the Open Door principle and equality of economic opportunities. Recently the term " Open Door " has come frequently to be used to mean a phase of the so-called " equitable treatment of commerce " as provided in Article 23 of the Covenant, of which spirit Japan, from the very outset, has been and even now is a conspicuous advocate.

" With the disappearance of those spheres of influence " said Ambassador Hirose Saito, speaking before the Foreign Policy Association in New York on January 5, last year, " the Open Door policy has become the synonym of equality and justice in commercial relations among all nations," and not a policy between the strong over the weak, as was the case in the first and second stages of its evolution. Moreover, in the last stage of development of the open door principle, once more political significance is fast receding in favor of the purely economic. So much so that the time-honored phrase is now being used among the members of the League of Nations as meaning equality or equitable treatment of one another confined to matters economic.

However, no one can dogmatically define on just which stage China is now travelling. It is safer to say that she is traversing a combination of these several stages, which now guide the destinies of China. In this connection a few of the multitudinous problems may be pointed out which are not confined to any sphere or geographical area, but which entire China (if such a united action is imaginable) must face and is facing the best she can in a hand-to-mouth fashion, or with vacillating opportunism. Take such enterprises as railways, telegraph, telephone, investments or employment of foreign advisers, though they may present delicate cases of exclusive rights or otherwise, heretofore they have been considered as confined to certain areas. However, with the development of radio and aviation, everything is international in its scope of operation. Can China, for instance, permit landing facilities to America's China clippers, and not to British Imperial or Japanese Air Mails. What about favoritism relative to international radio hook-up privileges ?

III—Present Day Difficulties of the Open Door Policy

We now come to the difficult problems that confront the doctrine which was once considered as a cure-all for the ailments of the Far East. Since they are so extensive and exhaustive, we may merely touch upon two or three.

(1) *Case of Boycott.*—Foreign trade is without doubt the principal item to be governed by the time-honored doctrine. But the boycott of foreign goods is a chronic malady of China. If directed against all foreign peoples there is no discrimination, but when a nation is singled out, the question naturally arises whether such an enterprise is to be tolerated under the Open Door doctrine of equal opportunities, if not, indeed, under the ordinary routine of international trade. Boycotts as a retaliatory weapon cannot be ignored, but the indulging in them by agitators, as an initial instrument of national (even though disorganized) policy or their being secretly supported by government agents, as a clandestine instrument of public policy certainly deserves careful study by students of international economic relations. For their consequences are not limited to China alone and have direct bearing upon "equality of economic opportunities."

The organized abusing or scrapping of Japanese interests and disregarding of Japanese rights became a well defined policy of the Chang Hsueh-liang regime in Mukden, or the Kuomintang regime in Nanking. When his father tried to oust the Red Russians in 1929, they poured troops into northern Manchuria without giving its masters any opportunity for a single word or murmur. Shifting his efforts toward the scrapping of Japanese rights, he not only intimidated the Japanese wherever possible, but used force against his own people with whom the Japanese citizens were in legitimate economic relationship. Hundreds of these cases could be cited if necessary. However, one conspicuous case, which provided one drop more than Japanese patience could hold, may not be amiss. The reader will recall that a number of Koreans secured a lease of land, and they also obtained the right of way to irrigate the land. The Chinese authorities used pressure to undo the privileges thus obtained by the Korean subjects of Japanese nationality. This provoked a mob action in Korea resulting in the ill-treatment of a few Chinese. This was the signal for the launching of a widespread boycott of Japanese goods in China without waiting for a conference or negotiations. The Mukden Incident ensued The Kuomintang famed boycott raged through the Yangtze Valley like wild fire and illegal excesses and violence were perpetrated, not only against their own countrymen, but against the lives and property of Japanese on the banks of the Whampoa River. It was these riotous, uncontrolled outrages directed against one signatory by another to the Washington agreement relating to open door that provoked the Shanghai Incident in 1932 ; and the hostilities now raging followed also a more or less similar course.

(2) *Case of Smuggling.*—Another practical difficulty may be mentioned. Some may claim that smuggling illegalities are universal and mutual We might as well acknowledge the fact that smuggling on a large scale is going on on all sides in China, although what constitutes smuggling depends upon the status of the regime which claims the power of control over a given trade. However, it is primarily China's domestic question. That smuggling takes place in China is only natural when one considers the fact that Nanking's controlling hands do not extend to frontier provinces of the country. Outer Mongolia, for instance, exacts charges on goods entering the province from China, whereas those coming from Russia are free. Tanatuva, adjoining Mongolia, is even freer than Mongolia, if such a thing is possible. Sinkiang is nearer to Moscow than to Hankow in economic organization, enjoying special preferential treatment. Thibet is virtually a foreign country, more closely connected with India than with Peiping. Yunnan charges only one per cent *ad valorem* customs on all French goods coming through the province, whereas the Chinese maritime tariff level in other parts is by no means the lowest in the world.

It is also a notorious fact that while General Chen Chih-tang was in control of Kwantung Province as a quasi-independent entity, his gunboats made weekly trips to Hongkong, always returning loaded with imported goods on which no duty was paid. One time, by mistake, they discharged the smuggled goods at the French Wharf, and the goods were seized by the Central Customs authorities headed by a foreigner.

Figures are quite eloquent. Three provinces as the Hinterland of Canton have a population very close to one hundred million. Customs income through the Port of Canton was in the neighborhood of ten million in 1936. Take the hinterland of three or four provinces of Tientsin, which again is composed of another hundred million inhabitants. At the same time, the customs income in that area amounts, we are told, to about thirty-five million. Yet nobody in China will agree that Canton's Hinterland is that much poorer than that of Tientsin. Japanese trade in the North, where they contribute three times to the coffers of the Chinese Maritime customs, has been dubbed as smuggling, because some of them were paying duty to the local Eastern autonomous regime, while the remainder of the 6,000,000 that went into the illegitimate and unrecognized Canton regime has been unheralded or hush-hushed.

China is anxious to stop smuggling in the neighborhood of Hongkong. To that end she has long hoped for the privilege of establishing a customs station in the Island. Now the question arises (under the second stage interpretation of the Open Door doctrine), what could be the *quid pro quo* for which Great Britain might be tempted to acquiesce ? Could it be the through railway facilities and extension of Hankow-Hongkong railway to Kowloon or the privilege to fortify the leased area. Is it purely economic, hence an open door question, or strategic, hence a political ? Can it be as easily dispensed with as people expect under the usual heading known as the open door policy ?

(3) *International Economic Organism.*—Let us take another trying case. Much to our regret, these are the days of controlled or planned economy and international economic organism. China, where the Open Door policy is supposed to operate, may be merely an incidence to the operation of another economic entity. The reader is no doubt aware of America's silver purchasing policy, which in turn resulted in the rise in China's silver, which was her currency.

In order to keep the metal from finding its way to America an embargo was placed against it, and later the equalization charges, equivalent to the difference in the prices of silver in America and China, were imposed. Simultaneously there was an attempt on the life of China's Prime Minister, Wang Ching-wei. The flight of silver was almost uncontrollable, and it was at this juncture that China decided to go off the silver standard and adopted managed currency, making paper notes legal tender. The question arose whether the new Chinese dollar was to be hitched to the sterling or to the dollar : in other words whether China would go into the so-called sterling bloc or the dollar bloc, or how near is it to be to the Yen.

The United States, apprehensive of silver dumping by China, immediately lowered the purchasing price of the commodity. Finally an agreement was reached between China and the United States. Considerable progress has no doubt been made since, due to the recent tripartite exchange agreement in Europe. It is beyond our comprehension to foresee the possible scope of foreign economic influence or alignment in China in favor of one as against another. Where is the open door policy of equality in the face of these realities ? Its application is no longer confined to the imperfectly controlled area known as China. China willing and agreeable, discrimination against or freezing out one nation in China can be effectively manipulated ten thousand miles away from the shores of China.

IV—Conclusion

These are unusual times. A person is ill-advised to deduce his conclusions out of exceptional conditions of momentary character. We can do no better than to borrow Baron Shidehara's words at the last session of the Washington Conference in 1922 to define Japan's unchanging attitude towards the Open Door policy.

> " To say that Japan has special interests in China, is simply to state a plain and actual fact. It intimates no claim or pretension of any kind prejudicial to China or to any other nation.
>
> " Nor are we actuated by any intention of securing preferential or exclusive economic rights in China. Why should we need them ? Why should we be afraid of foreign competition in the Chinese market, provided it is conducted squarely and honestly ? Favored by geographical position, and having fair knowledge of the actual requirments of the Chinese people, our traders and business men can well take care of themselves in their commercial, industrial, or financial activity in China without any preferential or exclusive rights."

Indeed it was Japan who had China open her doors in Shashi, Soochow, Chungking and Hangchow at the conclusion of the Sino-Japanese war. It was Japan who had China open seventeen trade ports and markets in Manchuria at the conclusion of the Russo-Japanese War. It was the very same Japan that fought with the Germans in order to return Kiachow to China which she did after the Great War. Devoid of any political or strategic aspect Japan has never stood in the way of a fair and open trade in China or Manchuria.

(Continued on page 51)

Twenty Years of Bolshevism

By a Correspondent in The London Times of July 5, 6 and 7, 1937

THE year which sees the twentieth anniversary of the Soviet regime, the inauguration of a new Constitution, and the adoption of a third Five-Year Plan would in any case be a landmark in Russian history. But these auspicious occasions are now eclipsed in the popular mind by the bloody reprisals of the past weeks.

The execution, after a summary trial *in camera*, of eight army commanders, followed by the wholesale dismissal and arrest of "spies," "wreckers," and "Trotskyists" all over Russia, can indeed be differently interpreted. On one view it is the beginning of the end. This opinion, the wish being father to the thought, has been widely hinted at in the German press; and it will, perhaps, be shared by those "friends of the Soviet Union" in this country who had been so lately expatiating on the Soviet conversion to democracy. On another view, which is that of the Soviet press, the recent terror means the consolidation of the Soviet power. And this interpretation seems, on any impartial estimate, the sounder. The Soviet Union is governed by that kind of despotism which is customarily, though perhaps unjustifiably, labelled "Oriental." Cutting off the heads of the tallest poppies has always been a favorite technique of despotism; and the most sentimental historian will hardly deny that it has often been an effective means of consolidating power for considerable periods.

The details of the drama whose principal scenes have been enacted behind the walls of the Kremlin and in the cells of Lubyanka are, and probably will remain, unknown. All the evidence suggests that the initiative came from those in possession. M. Stalin struck before his enemies had had time to prepare their blow, perhaps before they were conscious of being his enemies at all. There has been no trace of any popular movement. Proletarian and peasant have not been called upon to play even a walking-on part. The issue, if issue there was, was a struggle for power between rival or potential leaders. Yet there is no doubt that Moscow has passed through a severe crisis; and June, 1937, may well be treated by the historian of the future as a turning-point in the fortunes of the Soviet regime. It is an excellent vantage point for the observer who seeks to discover what has become, twenty years after, of the Russian revolution.

The central and fundamental fact about contemporary Russia is that the country is in the throes of an industrial revolution comparable with that which transformed Western Europe one hundred years ago. It is officially claimed that the industrial production of the present territory of the Soviet Union is now more than seven times, the agricultural production one and a half times, and the national income four times what they were before the War. The number of workers engaged in industry has risen from some 8,000,000 fifteen years ago to more than 25,000,000 to-day, and well over a third of the population is now dependent on industry.

Population Shifting

Like corresponding movements elsewhere, the Russian industrial revolution is causing a rapid shift of the density of population from country to town. Before the War only 20 per cent of the Russian population lived in cities; now 35 per cent is urban. Not only is there a constant drift of population to the towns in search of the better conditions available there, but the birth rate is soaring in the towns and almost stationary in the countryside. The recently issued figures for the first quarter of 1937 are partially explained by the ban on abortion having been far more effective in the towns than in the country. But they are sufficiently remarkable to deserve quotation. The increase in the birth rate over the corresponding quarter of 1936 for the whole Soviet Union was in the neighborhood of 30 per cent. In Moscow it was not far short of 80 per cent, and in some cities it rose to 90 per cent. Paradoxical as it may seem, the Soviet Union is not so far away from the problem of other industrial States: a depletion of the rural population. All this is merely another way of saying that the Soviet regime has been far more successful in tackling the industrial than the agricultural problem. Ever since Trotsky began to talk of the "scissors crisis" in 1923 the agriculturist in the Soviet Union has had a raw deal. He has been obliged to produce cheap bread and potatoes for the factory worker, while the factory worker has been given no encouragement at all to produce cheap boots and shirts for the agriculturist; and during the past four years the disparity between town and country workers has still further increased. In his new guise as a collective farmer the Russian peasant still, as of old, gets all the kicks and few of the halfpence.

For the Russian industrial worker the Soviet regime has done much. It has given him reasonable security of employment and what is by Russian standards a living wage. According to official statistics the average wage of the worker in Soviet industry for the current year should be about 250 roubles a month. But this figure includes the specialists and the "black-coated workers," who, though they do not wear black coats, seldom get less than 600 roubles, and often twice as much. It may be doubted whether many manual workers outside Moscow and Leningrad (where rates tend to be higher than elsewhere) touch 200 roubles.

With potatoes at a rouble a kilo and rye bread a few kopeks cheaper, the Russian workingman at home lives mainly on these staple commodities, eked out perhaps by salt fish and vegetables in season. He rarely sees meat outside the factory dining-room and never butter, which has fluctuated during the past winter in Moscow between 18 and 24 roubles a kilo (Marshal Voroshilov's preference of guns to butter is less outspoken, but not less effective, than that of General Goering.) A poor shirt costs him a week's pay, and a month's wages will not buy him the shoddiest suit of clothes. Rent is low, though his whole family, including a stray grandparent or aunt, is quite likely to be sleeping in a single room. But the Soviet factory worker has few regrets. He is better off than he has ever been. He is better off than his country cousin. He is better off—so radio, press, trade union leader, and party official all conspire to assure him—than the worker in any capitalist country. Soviet Russia is the paradise of the workers.

Effects of Revolution

It would, however, be misleading to accept altogether at its face value the official theory that the Soviet State is run for the benefit of the worker. Economic and social laws do not cease to operate even under a Marxist dispensation. The Russian industrial revolution has produced results recognizably similar to those of the Western industrial revolution a century ago. It has brought into power in Russia, as it did in the West, not the proletariat which provides the muscles and sinews of industrial production, but a new social stratum, appropriately defined as a "middle class," which supplies that production with brains and capital. Nor does it matter that in Russia the owner of the brains is a bureaucrat, and the owner of the capital the State itself. A bureaucrat is a human being, and a State (just like a limited liability company or a bank) is composed of human beings; these human beings have their economic needs and ambitions and create their social tradition. The first instinct of the new Russian bureaucrat—the capitalist and the black-coated worker of the industrial revolution—is to achieve a standard of living which raises him above the proletarian rank and file. He wants better food and lodging, better clothes for his wife, better seats at the theater, the possibility of choosing his own doctor and consulting him without having to stand for hours or days in a hospital queue, and a thousand other benefits and privileges which in Russia, as elsewhere, are the prerogative of the comfortably off; and, having these privileges, he wants an efficient State machine, with an efficient army and police, to secure him in the possession of them. All these things the new Russian middle class, composed mainly of officials, engineers, managers, clerks, Red Army officers, and professional men of all kinds, is slowly but surely acquiring.

Of the earnings of this new bourgeoisie it is difficult to speak with precision. In money wages the best paid people in the Soviet Union are the artists. A first-class actor will get his ten thousand roubles a month. A popular, but not the most popular, living

Russian novelist was recently stated in the press to be drawing over one hundred thousand roubles a year in royalties. The highest salary of all is reputed to be that of a jazz-band leader. The manager of the big industrial or commercial trust, the high government official, and the party boss are in a different category. It would be sacrilege to inquire what is the salary of M. Stalin, or of a people's commissar, or of a Soviet marshal. The salaries officially assigned to such exalted personages are probably of modest dimensions. But these aces of Soviet political, military, and economic prowess are kept in such magnificence as the Soviet State can provide, including many luxuries which cannot be bought in the Soviet Union for money—private houses and motor-cars, travel facilities, and imported goods. To accumulate would be meaningless, for they could leave their present greatness only for the condemned cell or the penal settlement, where the State continues to provide for their needs on a more frugal scale. They have risen above the level of a money economy.

But in considering the status of this new bourgeoisie, the backbone and principal beneficiary of the Soviet regime, one important reservation must be made. Classes in the Soviet Union have not yet crystallized, and may never crystallize, as they did after the industrial revolution in Western Europe. The proletarian need not remain a proletarian or the peasant a peasant. Already the "Stakhanovite" worker may, by hewing a superhuman tonnage of coal or pulling an incredible number of beets per hour, earn five or fifteen times the wages of his fellows and climb into the well-to-do class. The son of the coal-heaver has as good a chance as the son of a clerk or a commissar of finding his way into the privileged circle. *La carrière ouverte aux talents* is the watchword in Soviet Russia. Classes there are; but a lot of talent and a little luck will clear the barriers between them.

Such a system, however laudable, marks an enormous departure from the principles of 1917. In the early days of the revolution the worker was encouraged to expect that the benefits of the proletarian State would be equally shared between the members of the proletariat. Nowadays the officially stimulated ambition of the worker is to emerge from the ruck, and, in his own person or in that of his children, to enter the deproletarianized and privileged middle class. The change is eminently practical. But the Russian mind has never been content to take the practice and let the theory go; and the task of adjusting the theory of 1917 to the practice of 1937 has been one of immense embarrassment; an embarrassment reflected in all the dissensions which have torn the ruling class in Soviet Russia during the past ten years.

A Retreat from Utopia

When Lenin seized power in Russia in November, 1917, his views on the nature of the State were unimpeachably Marxist. The State, being in its very essence an instrument for the oppression of one class by another, was therefore an evil which could have no place in the classless Communist society. In order to win the victory which would lead to the establishment of the classless society, the proletariat must seize the State machine and turn it against their old oppressors, the bourgeoisie. But the State would remain (for such was its nature) an instrument of class oppression; and it would be used as such by the triumphant proletariat to crush the bourgeoisie. This was, however, only a transitional period. The dictatorship of the proletariat, wrote Lenin, was "not an organization of order, but an organization of war." Once the bourgeoisie had been extinguished or rendered impotent, the State would become a meaningless institution (since there would be nobody left to oppress), and would, in the classic formula of Marx and Engels, "wither away."

In 1917 this Utopian conception, taken over straight from Marx and Engels, was an integral part of Lenin's creed. There is no evidence that his faith in it was ever shaken, though in his last years he once admitted that the transitional period before the State finally disappeared might be "a whole historical epoch." And the odd thing is that this conception still figures in the official creed of the Soviet rulers to-day. It is one of the most curious of contemporary paradoxes that M. Stalin, who has constructed the most powerful and most arbitrary State machine yet known in history, is compelled from time to time (though more and more rarely nowadays) to affirm that his real aim is the abolition of the State. The formula invented for the last Party Congress does not lack ingenuity. "The highest possible development of the power of the State with the object of preparing the conditions for the dying out of the State" is now M. Stalin's declared policy. The highest possible development of the State is the practice, the dying out of the State is the theory; and what is the good of dialectical materialism if it cannot prove in case of need that black means white and white black? The withering away of the State plays much the same rôle in Soviet dogma as the Second Advent in Christian theology. It occupies an essential place in every confession of faith. But since the days of the primitive Church the prospect has not been regarded as imminent or allowed to affect day-to-day practice.

Things in the Soviet Union have not gone quite so easily as that. It has become of late increasingly difficult, even in a country where the suppression of free thought is carried to the pitch of perfection, to disguise the fact that this "highest possible development of the power of the State" has knocked Marxism sideways. The State, it is true, retains the ownership and control of industrial production. But in this respect the Soviet State has only carried to its logical conclusion a development which has also made gigantic strides in many capitalist countries. If (as Engels acutely observed) the taking over of industries by the State is socialism, then Napoleon, who nationalized the tobacco industry in France, must count as one of the founders of socialism. In that sense M. Stalin may be permitted to rank with Napoleon. In any other sense his claim to be regarded as a Socialist requires careful scrutiny.

The "principle of socialism," we are authoritatively informed by the new Soviet Constitution approved last December, is "From each according to his ability, to each according to his work." Between socialism thus defined and capitalism there seems to be no more than a hair's breadth. After all, the capitalist only takes from the worker "according to his ability" (*la plus belle fille ne peut donner que ce qu'elle a*), and asks for nothing better than to pay him "according to his work," unless the trade unions, more effective in democratic countries than in Soviet Russia, obstruct the adoption of this "Socialist" criterion.

Of the prevalence of such "socialism" in contemporary Russia there is no doubt. Examples have been given of the immense differentiation of wages and salaries in the Soviet Union. The right of inheritance has been restored; deposits in savings banks and investment in State loans (with lottery drawings) are being effectively encouraged; and private incomes derived from "work and savings" are specifically protected by the new Constitution. The creation of privileged grades, whose loyalty to the regime can be counted on, may be either a deliberate part of M. Stalin's policy or a natural consequence of the industrial revolution—or both.

Side by side with the great majority, exclusively bond slaves to labor, there arises a class freed from directly productive labor, which looks after the general affairs of society, the direction of labor, State business, law, science, art, etc.

This description, from the pen of Engels, of the rise of capitalism applies word for word to what is now going on in the Soviet Union. The existence in Soviet Russia of "exploitation" in the Marxist sense can only be denied on the unlikely hypothesis that the will of M. Stalin and the will of the worker are one and the same and that the worker is therefore exploiting himself. But if M. Stalin chooses to apply the label of socialism to a system which exhibits so many of the most characteristic symptoms of capitalism, none of his compatriots will dare to say him nay.

Changes the Years have Brought

The capitalist observer need not be disconcerted to discover that Soviet socialism is, after all, only capitalism writ large. But what of the sincere and intelligent Russian Marxist who remembers the slogans of the glorious revolution of 1917? Trotsky is known to-day in Soviet Russia, not as Lenin's principal coadjutor, but as the first and most wicked of counter-revolutionaries; and to be found in possession of any of his writings is a capital offense. But how many Russians are there who, whether consciously influenced by Trotsky or not, believe with him that the revolution has been "betrayed" by M. Stalin and his bureaucracy? Is there, in this sense, a "Trotskyist opposition?" The question is difficult to answer.

The treason trials of August and January signally failed to prove the existence of a "Trotskyist conspiracy." But it is hard not to believe that many thousands of "old Bolshevists" perceive to-day that the system evolved by M. Stalin is something very different from the system for which the Bolshevists fought in 1917,

and that the present regime, instead of moving towards the promised land of a classless society with no privileges and with distribution "to each according to his needs," is working night and day to establish and maintain a system based on precisely contrary premises. M. Stalin, who may have an uneasy Marxist conscience, clearly suspects the existence of such a body of opinion; and thousands of unadvertised arrests, in addition to the notorious ones, have been made in the past two years in the attempt to eradicate this source of disloyalty to the regime.

But most of the victims of the Stalinist terror probably belong to a different category. During the last five years the party line has taken so many hair-pin bends, and the pace has been so hot, that many competitors, with the best will in the world, have failed to stay the course. Such was the sad case of M. Pashukanis, until recently rector of the Institute of Soviet Law and Vice-Commissar of Justice. Down to last December M. Pashukanis had expounded in an able series of lectures and textbooks the Marxist-Leninist theory of law. According to this theory, law is an instrument of government in the hands of the ruling class. Like the State itself, it is essentially repressive in character, and is an evil which will ultimately wither away with the State. The Soviet judge, argued M. Pashukanis, was entitled if need be to rise above the letter of the law and decide on the strength of what Lenin called his "revolutionary consciousness of right."

But M. Pashukanis, in his rectorial and vice-commissarial armchair, failed to move with the times. About the end of last year some acute critic (perhaps a professional rival) discovered a flagrant incompatibility between this doctrine and Stalinism. The theory of "the highest development of the power of the State" clearly required the rigid enforcement of State law, whose authority M. Pashukanis was so recklessly undermining. In January M. Pashukanis was deposed from his official position. His numerous textbooks disappeared overnight from circulation, and his teaching was branded as "anarchic." Two months later he was arrested as a wrecker and a Trotskyist. His present whereabouts is unknown.

The case of M. Pashukanis has been quoted, not for its intrinsic importance but because it is typical of what is occurring everywhere in Russia at the present time. Official orthodoxy has performed marvels of prestidigitation in its efforts to adapt Marxist theory to Stalinist practice. Almost everyone who has had the misfortune to write or speak in the Soviet Union on politics, law, art, or letters must have been guilty at some time or other of an utterance which would now be condemned as arrant Trotskyism. Nobody in high place knows when some such utterance may be conjured up from the past to bear witness against him. The orthodoxy of yesterday is the heterodoxy of to-day; and, except for the (much revised) works of Stalin and the (slightly expurgated) works of Lenin, it is virtually impossible to find in any Soviet bookshop to-day any Russian work of a political character published between 1914 and 1934. Most of the pundits of the older dispensation have been put under the ban. Those who have been agile enough to remain in favor ask nothing but forgetfulness for their indiscretions of yesteryear. And in no sphere has the reversal of Soviet policy in the past five years been so abrupt and so complete as in international affairs.

Soviet Policy Abroad

The maladjustment between the Marxist theory of the "withering away" of the State and the Stalinist practice of the "highest development of the State" is matched in the international field by a corresponding maladjustment between the old Bolshevist slogan of "world revolution" and the Stalinist slogan of "socialism in a single country." The Marxist theory of revolution assumed that revolution would be world-wide or, at any rate, European. A revolution which did not extend to an important industrial country like England would, Marx once remarked, be a mere storm in a tea-cup. The establishment of proletarian communism presupposed the disappearance of national boundaries.

These assumptions were fully shared by the first generation of Bolshevists. At Brest-Litovsk the Russian negotiators were prodigal of territory and interested only in the most expeditious means to spread Communist propaganda and hasten the coming of revolution in Germany and western Europe. The Bolshevists of the heroic age did not think in terms of States. Moscow was not the capital of a State, but the headquarters of the world-wide revolutionary organization of the working-class. Right down to the death of Lenin it was generally admitted that the Soviet State could not maintain itself indefinitely unless the revolution spread westwards; and to propagate revolution was therefore, if only for reasons of self-interest, the primary task of the Soviet Government. As late as 1924 M. Stalin himself, in the now suppressed first edition of his "Questions of Leninism," wrote that "the victorious revolution in one country . . . ought not to be considered as of independent value, but as an auxiliary, a means of hastening the victory of the proletariat in other countries."

But facts were too strong for this ambitious missionary plan. The rest of the world obstinately insisted on remaining divided into national States; and Russia, compelled (if only by way of resistance to attack) to assert her identity against the outsider, assumed perforce the semblance of a national State. In 1921 Lenin retired from the turmoil of "war communism" into the quieter waters of the New Economic Policy, and concluded a trade agreement with Great Britain. This agreement was followed by others. The incompatibility of preaching world revolution in one breath and seeking amicable relations with capitalist States in the next became gradually apparent; and this fundamental maladjustment of Soviet policy came home to roost, nine months after Lenin's death, in the farcical incident of the "Zinoviev letter."

In the next two years the issue of "world revolution" versus "socialism in a single State" became the chosen battleground between "Trotskyists" and "Stalinists"; and in 1928 M. Stalin celebrated his victory by introducing the first Five-Year Plan. It is a curious fact that a State which is a going concern acquires, independently of its own volition, a sort of vested interest in the political and economic stability of other States. It soon became clear that the worst thing which could happen to the Five-Year Plan would be a political or economic upheaval affecting world prices or the purchasing power of Russia's principal customers. World revolution, far from being the primary objective of Soviet policy, would be a disaster of the first magnitude. The world economic crisis was a period of great anxiety for the directors of the Soviet economy; and if the Soviet Union escaped its worst symptoms the escape was due not to its peculiar political organization (Palestine is another instance of a country untouched by the economic crisis), but to the progress of the industrial revolution. Now, on the eve of the third Five-Year Plan, Soviet economists are trembling lest their careful calculations should once more be thrown out of gear by a change in the gold policy of the leading capitalist countries, the Soviet Union having become the second largest producer of gold. Since 1928 the international reactions of Soviet Russia have been precisely similar to those of any ordinary capitalist State.

The Last Step

A further development came when Germany and Japan left Geneva in 1933. Menaced by the growing turbulence of these two "dissatisfied" Powers, the Soviet Union took the last step in the transformation from international rebel into international conservative. The State whose professed ideological basis in the "dynamic" creed of dialectical materialism joined the "static" group of respectable, satisfied Powers, and became a member of what M. Tchitcherin always elaborately referred to as "the so-called League of Nations." Since that time no member of the Council of the League has been more insistent on the importance of keeping things as they are, or more cautious in deprecating the most distant allusion to the one article of the Covenant which hints at the possibility of international change, than M. Litvinov. It is the last and most remarkable metamorphosis of the most dramatic revolution of modern times.

Meanwhile the Communist International, founded in the hectic days of 1919, when world revolution seemed—and not only to its supporters—a probable and perhaps imminent event, has fallen sadly from its former glory; and bourgeois governments all over the world no longer tremble at its name. In the first years of the regime, Comintern held regular annual congresses in Moscow which rang with the familiar denunciations of the capitalist system. But after the inauguration of the first Five-Year Plan in 1928 no further congress was convened for seven years. Denunciations of capitalist countries were no longer a convenient accompaniment of the policy of "socialism in a single State." In 1935, however, Comintern rather unexpectedly revived in a new guise, no longer as the *enfant terrible*, but as the obedient agent, of Soviet foreign policy. Fascism had supplanted capitalism as the enemy of the proletariat. The British or French or American worker striking against his capitalist

employer can no longer count on the support, material or even moral, of Comintern. The French Communist is adjured from Moscow not to vote against the military budgets even of a Right Government in France. The British Communist is urged to seek a common front with those Labor leaders whom he had previously learned to denounce as the worst enemies of the working class. The Chinese Communist is ordered to co-operate with Chiang Kai-shek, formerly known as the butcher of the Chinese revolution, for the purpose of resistance to Japan. The present policy of Comintern rests on the assumption that the political exigencies of the Soviet State are identical with the world-wide interests of the working class as a whole. It is not surprising that this assumption should be made by a body whose seat is in Moscow and whose non-Russian members have always regarded loyalty to the party line as their first duty. It is also not surprising that, outside the Soviet Union, the assumption should have found readier acceptance among Left intellectuals than among the workers themselves.

The foreign policy of Soviet Russia and the policy of Comintern depend therefore no longer on principles which can be found in Marxist textbooks, but on the same considerations of enlightened self-interest which determine the foreign policies of democratic or Fascist countries. Adherence to the party line is none the less rigidly enforced. One semi-official explanation of the recent execution of the eight generals is not that they were in the pay of Germany (for this story, though official, seems to reflect too much discredit on the intelligence of those who appointed them to the highest military posts), but that they were advocating a *rapprochement* with Germany. The explanation is not plausible; for Marshal Tukhachevsky in particular was known for his devotion to the Franco-Soviet Pact and his support of a Franco-Soviet military alliance. But it is true enough that the firing-squad or penal servitude would at the present time await anyone in the Soviet Union who, however honestly, advocated German-Soviet friendship (just as it would have awaited, before 1933, anyone who proposed that the Soviet Union should join the League of Nations). Whether the party line is based on principle or pure opportunism, deviation from it is equally fatal to the deviator.

This is not to say that the foreign policy of Soviet Russia will not change. The theory that the Soviet Government is interested in the creation of a "Left front" for the defense of democracy against fascism is a Western invention which receives no support from the official exponents of Soviet policy. The present enemies of the Soviet Union are the so-called Fascist States; and Soviet propaganda can therefore be directed against fascism as a whole. But if one of the Fascist States were to detach itself from the group the Soviet Government would welcome the friendship of the seceder as cordially and wholeheartedly as that of any democratic country.

There was a period of Soviet-Italian friendship in 1930 when M. Litvinov visited Rome and clinked glasses with Signor Mussolini. The student of international affairs will not exclude from his speculations a possible recurrence of this pleasing episode. If the Soviet Government saw a favorable opportunity of securing the assistance of Japan against Germany, or of Germany against Japan, it would see no reason to shrink from such a step. Conversely, if a Right, or even a professedly Fascist, Government came into power in France, this would not, in the eyes of the Soviet authorities, affect Franco-Soviet friendship provided the foreign policy of France remained unchanged. The desire to line up against one another the conflicting ideologies of contemporary Europe belongs entirely to Herr Hitler, not to M. Stalin.

Of the aggressive Asiatic policy which was once so exasperating a thorn in the side of Lord Curzon, scarcely a trace remains. It is many years now since a congress of Eastern peoples swearing a holy crusade against the British Empire was held on Russian soil. If Comintern still nourishes a hope that the oppressed peoples of Africa and Asia will rise against the white capitalist, it keeps this ambition discreetly to itself. Of late years the Soviet Government has pursued a forward policy only on what is nominally Chinese soil—in Outer Mongolia and in Sinkiang; and its successful efforts to plant Soviet influence there were probably inspired by the fear of being anticipated by Japan rather than by any native urge to expand.

The Soviet Government has its hands full at home. Fear of Germany and Japan are an effective curb on ambitions abroad. In spite of a momentary breeze at the Montreux Conference last year, there is at the present time no serious clash anywhere between British and Soviet interests, except in so far as Soviet influence in France diminishes the prospects of a settlement with Germany. Present Soviet policy, domestic and foreign, may well puzzle the orthodox Communist. But the capitalist will not easily be convinced that it contains any new recipe for salvation hitherto undiscovered by the capitalist world.

Britain on the Seas

By HECTOR C. BYWATER, in Foreign Affairs

SPEAKING at Geneva on September 20, Mr. Anthony Eden, the British Foreign Secretary, said: "At present the aggregate tonnage of the principal types of warships actually building for the Royal Navy exceeds 450,000 tons. I take no account in this figure of the ships already launched this year, nor of a further 55,000 tons which Parliament has sanctioned and which will shortly be put in hand. The last three naval programs partly completed or in actual execution in the United Kingdom at the present time represent a total expenditure of £130,000,000. Naval personnel is being extended at a rate without precedent in our country in time of peace."

Impressive as these figures are, they do not adequately reveal the magnitude of the effort which Britain is now making to restore and consolidate her sea power. Tables published in the Navy Estimates for 1937 show the following combatant and auxiliary units as under construction during the current fiscal year: five battleships, 21 cruisers, five aircraft carriers, 49 destroyers, 19 submarines, three depot ships, 24 escort, mine-sweeping and patrol vessels, three gunboats, 17 motor torpedo-boats, and two surveying ships—a total of 148 vessels. Nor is this the whole story. A new program is to be introduced to Parliament next March, and while its details are not yet officially revealed, well-informed observers predict three to five battleships, seven cruisers, and a generous quota of destroyer, submarine, and other light tonnage. The personnel of the Navy, which has jumped from 98,000 to 112,000 in the last few years, will be further increased to an approximate total of 125,000 officers and men.

What is the purpose of this gigantic scheme of naval rearmament? That it has been undertaken for reasons of defense, and not for aggression, is self-evident to all foreign onlookers save the wilfully blind or the victims of propaganda from the dictatorial countries. But behind every arms plan there must be, or should be, a definite strategical objective. In this case it is not difficult to perceive. When Sir Samuel Hoare, the late First Lord of the Admiralty, introduced this year's navy budget, he spoke of a "two hemisphere fleet" as the goal in view. This can only mean that Britain intends to become strong enough to be capable of holding her own simultaneously in European waters and in the Far East. Having regard to the present balance of power in the world, that is a big order. But if the British Commonwealth is to survive it must be fulfilled.

For Britain the potential danger zones are the North Sea, the Mediterranean, and the Western Pacific, and in the absence of a general movement towards appeasement those zones must continue to be carefully watched. It goes without saying that an Anglo-German accord would simplify Britain's defense problems to an incalculable extent. Relieved of anxiety in northern waters, she would be able to concentrate sufficient force in the Mediterranean to defend her line of communications there, while retaining a margin of strength to oppose a strong front to aggression in the Far East. But whether that happy state of affairs will ever come to pass remains to be seen. Not the least valuable feature of the Rome-Berlin axis to its two engineers is the possibility it offers for one to create a naval diversion to relieve the other. Even when her

present program is completed, Britain could hardly muster overwhelming force in the North Sea and the Mediterranean at one and the same time, and even were she able to do this it would leave her virtually defenseless in the Pacific. On the other hand, it is scarcely conceivable that she would be fighting singlehanded a coalition of Powers, and in the existing system of international grouping those Powers on whom she might reckon for support are excellently placed for intervening in the Mediterranean and the Far East.

Facing Possibilities

Despite the fact that no thoughtful Briton can be satisfied with this grouping, actualities must be faced. For the present, Britain, France and Russia are bound to consider the prospect of joint defensive action against Germany, Italy and Japan in the event of a new world conflagration. And that a local war involving two of the Great Powers would inevitably develop into a world war is almost the only point on which the political pundits are in complete agreement. Let us, therefore, consider the strategical situation that would arise if these rival three-Power *blocs* came into collision.

Britain already is strong enough at sea to deal faithfully with the German Navy and to spare a powerful detachment for Mediterranean service. Thus aided, the French Navy should be fully competent to settle accounts with Italy, whose naval power is vested mainly in weapons—fast and light surface craft, submarines and airplanes—which are difficult to co-ordinate strategically or tactically and may prove less formidable than they look on paper. No flights of rhetoric from Rome can conceal the fact that Italy is in a bad strategical position. The prerequisite condition of her retention of Abyssinia is unrestricted use of the Suez Canal, and not merely of the Canal itself but of its approaches as well. In other words, she must be sufficiently strong to command both the Eastern Mediterranean and the Red Sea That she could never do in face of an Anglo-French coalition. Nor is that all. Notwithstanding the manful efforts she is making to become self-supporting, Italy is still largely dependent on imported supplies. Even under the half-hearted system of sanctions applied in 1935-36 she was beginning to feel the pinch. An effective naval blockade would speedily produce far more painful results.

Italian spokesmen are fond of reminding the world that the strength of their air force would more than compensate for weakness at sea. During the trouble with Britain two years ago they threatened to make Malta untenable, and they still believe—though not entirely with justice—that this threat was responsible for the temporary withdrawal of the British Mediterranean fleet to Alexandria. What they overlook is the fact that Malta is not of absolutely crucial importance to the British Navy. There are other British bases in the Mediterranean, actual and prospective, from which the fleet could operate very comfortably, bases out of reach of the Italian heavy bombers but ideally situated for dominating the only two passages out of the Mediterranean basin. Furthermore, air raiding is a two-edged weapon, and certainly the last with which Italy, if she were wise, would threaten her neighbors. With the possible exception of Japan, no country is more vulnerable to this method of warfare.

And last but not least, while freedom of movement in the Mediterranean is indispensable to Italy in wartime, the same is not entirely true of Britain. If the latter were compelled to evacuate the Mediterranean for the time being she would be seriously inconvenienced, but no more. She could still reach India and the Far East by way of the Cape of Good Hope, at the cost of longer voyages and a temporary shortage of certain supplies. During the 1935-36 crisis over Abyssinia a number of British ships bound to and from the East were, in fact, re-routed via the Cape, and it is a safe assumption that plans for diverting the whole of this traffic have been prepared. In passing, attention may be directed to the far-reaching schemes of harbor and dock development which are now actually proceeding at Cape Town and Durban, not to mention other ports along the east and west coasts of Africa. Improvisation and "muddling through" may be the customary British practice in land warfare, but in conserving its vital lines of communication—in this case the sea routes—no Power exhibits greater prescience. As we shall see later, this traditional policy is being actively pursued at the present time.

Value of Mediterranean Products

Naval staffs are not in the habit of broadcasting their war plans, but the strategy to be pursued by Britain in the event of war with Italy seems fairly obvious. Britain imports every week of the year over a million tons of food and raw materials, and it is widely assumed that a very high proportion of these supplies derive from the Mediterranean. In normal times, it is true, 20.1 per cent of her aggregate imports pass through the Strait of Gibraltar, but only 11.4 per cent come from sources inside the Mediterranean itself, the remainder having traversed the Suez Canal. It will be seen, therefore, that the closing of the Mediterranean commercial highway would deprive Britain of little more than one-ninth of her total oversea supplies, for the cargoes coming from places east of Suez could, if necessary, be sent round the Cape. Furthermore, of the 11.4 per cent originating in the Mediterranean, only a very small proportion represents food. The bulk consists of cotton, minerals, and chemicals, and for many of these commodities there are alternative non-Mediterranean sources of supply. It is, then, no more than the simple truth to assert that were the use of the Mediterranean route to be denied to British merchant shipping, Britain herself might be inconvenienced but would certainly not be crippled.

In the writer's opinion, it is more than possible that in the event of war the British naval staff would promptly declare the entire Mediterranean "out of bounds" to merchant shipping—with the possible exception of tankers, for which strong convoy escorts might be provided; would re-route the Indian and Far East trade via the Cape; and would concentrate on the task of maintaining strategic control of the Gibraltar-Suez route by the employment of naval and air forces. With the elimination of merchant shipping from the immediate war zone, the task of the British armed forces would be immeasurably simplified. Possessing well-defended bases at Gibraltar, Malta, Alexandria and Cyprus, they should be in a position not merely to offer a strong resistance to Italian aggression, but to deliver heavy counter-blows, the nature of which need not be specified. Against a possible German diversion in the North Sea must be set the virtual certainty that France would be an active ally of Britain in the Mediterranean. Since these considerations must be equally patent to Signor Mussolini, one may be permitted to doubt whether his future plans really include an unprovoked attack on Britain, an attack which would indubitably array against him the united strength of the whole Commonwealth.

As long as the Anglo-German naval agreement of 1935 remains in force—and it is expressly stated in the documentary exchange that it is to be a permanent arrangement—the total German combatant tonnage will not exceed 35 per cent of that of the British Commonwealth. It is true that two factors join to give Germany a somewhat higher relative strength than the ratio indicates: first, because her fleet is of absolutely modern construction and will contain none of the over-age tonnage with which the British fleet is, and will continue to be, burdened; secondly, because Germany can count on massing the whole of her fleet in the North Sea and (or) the Baltic, whereas Britain must always maintain powerful squadrons in the Mediterranean and the Far East, and can never hope to have more than half her Navy available for service in home waters. This notwithstanding, the German Navy is not likely to become a serious menace while the 1935 agreement endures. Recent suggestions from Rome that Germany contemplates a revision of the pact in the near future are probably a case of the wish fathering the thought.

There is no doubt that the one "depressed area" in the field of British strategy is the Far East. Here her weakness is as palpable as the impossibility of remedying it at an early date is plain. When the Washington Five-Power Agreement was signed in 1922 the British and American naval experts were under no illusion as to its strategical consequences. They were fully aware that the keys of the Western Pacific had been presented to Japan as a free gift, but no doubt they hoped that she would not abuse the gift. As a safeguard against this contingency the Nine-Power Treaty was concurrently negotiated. Recent events in China are calculated to shake the faith of the most confirmed idealist in the value of parchment safeguards.

British interests in the Far East greatly exceed those of any other Western Power, not excluding the United States. Apart from "real estate," represented by Hongkong, Britain has enormous capital investments in China, the loss of which would deal her a staggering blow. Then there are her possessions in Malaya and Borneo, whose natural wealth is considerable. Australia, a vast and thinly peopled continent, contains enough territory to

satisfy the most rapacious of the "have not" Powers. All these interests and properties must be defended in the last analysis by the British Navy, for in no case are the local defense forces adequate to withstand attack by an aggressor of first-class rank.

The Singapore Base

Previous to the completion of the new naval base at Singapore, Britain's strategic position in the Western Pacific was critical. Nowhere in that area was there a single dock to take modern battleships; yet without docking facilities a fleet is for all practical purposes immobilized. To-day, or at any rate in the very near future, three of the largest warships can be docked simultaneously at Singapore. The next step is to provide ships to fill the docks. For the time being no capital ships can be spared from European waters, but as the naval program matures new battleships will come forward to relieve the older units, which may then be available for service in the Pacific. According to unofficial news published in London, the five modernized battleships of the *Queen Elizabeth* class will eventually be stationed at Singapore, which is then expected to supersede Hongkong as headquarters of the Pacific Fleet. With the battleships will be one heavy and one light cruiser squadron, several airplane carriers, and an appropriate force of destroyers and submarines. If the Pacific Fleet is organized on these lines its strength will be equivalent to that of the present Mediterranean Fleet. Should war become imminent it would no doubt be reinforced by the Australian and New Zealand squadrons, comprising two heavy and three light cruisers, all modern. The projected Pacific Fleet will thus be a formidable organism, and one that will enable Britain, for the first time since the World War, to provide fairly adequate protection for her vast interests in that ocean.

It is true that the projected fleet will be markedly inferior to the Japanese Navy, but it should be strong enough to practise the defensive strategy which the situation calls for. As long as this fleet remained "in being"—that is to say, intact and mobile—Japan would be unlikely to embark on any large-scale oversea expedition against British territory in the Pacific. In all probability, therefore, the appearance of the new fleet at Singapore will automatically banish the potential Japanese menace to Malaya and Australia, as well as to the Dutch East Indies. As regards the latter, the maintenance of the *status quo* is a no less vital matter to Britain than to Holland herself, and in the event of a Far Eastern conflict it is practically certain that the British forces would have the support of the modest but very efficient Netherlands squadron. The Achilles heel of the British Commonwealth in the Far East is Hongkong. It is much to be doubted whether this position could be held against a heavy Japanese attack, and many British strategists question the wisdom of attempting to do so. As they justly point out, the ultimate fate of Hongkong would be determined by the outcome of the war—a war, be it noted, in which economic forces would weigh hardly less heavily than armaments.

A word must be said about Russia as a possible participant in a Far Eastern war. Even if we discount the stories of an immense fleet of Soviet submarines at Vladivostok, it is clear that Russia is in a position to make things very unpleasant for Japan. The existence of many hundreds of bombing airplanes in and around Vladivostok is not mere rumor but proven fact, and most if not all of Japan's industrial centers lie within their striking range. Whether air power is capable of forcing a decision in war is still an open question, but it is a reasonable assumption that repeated heavy raids on her teeming cities would compel Japan to take such counteraction as would gravely weaken her forces in other areas. Russia is the only Power which could strike directly, and in the very first days of war, at Japan's vital communications with the Asiatic mainland. It seems certain, therefore, that until the Soviet aero-naval forces based on Vladivostok had been destroyed or reduced to relative impotence, Japan would not be at liberty to engage herself deeply elsewhere. We may go still further and assume that war with Russia would so heavily tax Japan's military resources that she would have no margin left for an expedition against Hongkong, to say nothing of remoter British territories. Her fleet, too, would be so much occupied in guarding essential lines of communication that it would have few opportunities for aggressive operations. These considerations suggest that although Japan is the predominant naval Power in the Western Pacific, her command of the sea would not necessarily be absolute in the event of war with Britain and Russia.

Position of the U.S.

Nor can the possibility of American intervention be wholly ignored, though its treatment in this study must be regarded as academic. That an Anglo-American coalition would prove fatal to Japan is a proposition hardly likely to be disputed. Without dangerously denuding her Atlantic seaboard the United States could muster in the Pacific a fleet approximately equal in combatant power to the entire Japanese Navy, while the adhesion of a British battle fleet of five capital ships and their auxiliaries would give the combined force a decisive superiority. Nor is Japan to-day so inaccessible to the direct pressure of naval force as was the case up to a few years ago. Since 1934 the United States has been unobtrusively building, as it were, a strategical bridge between Hawaii and the Philippines, and at the same time surveying an alternative route to Japanese waters from the Aleutian Islands. Such stepping stones as Midway Island, Wake Island, Guam, and Dutch Harbor are regaining all the importance they possessed prior to the Washington Treaty of 1922. Moreover, it is still on the cards that the United States may decide to revive the pre-treaty plan of converting Guam into a major naval base. This will largely depend on what policy Washington elects to follow when the independence of the Philippines is an accomplished fact. If the United States should then undertake to guarantee the integrity of the islands, the creation of a big naval base at Guam would appear to be an inescapable necessity.

Having thus briefly reviewed the field of naval strategy as it appears to British observers, a rather more detailed account of Great Britain's current program of rearmament at sea may be appended. To the expert eye two facts are immediately apparent. First, the whole program is actuated by a definite conception of strategy based on the defense needs of the Commonwealth as a whole, and not—as in the case of the prewar naval expansion movement—directed to the establishment of supremacy in one single area, such as the North Sea. Secondly, every one of the scores of new ships now being built has been planned to develop maximum efficiency. At no time in the long and chequered history of the British Navy has so much care been devoted by its constructors to the seaworthiness, floatability and fighting power of individual ships. The vessels now on the stocks are designed from the keel upwards to face and survive ordeal by battle, however devoutly their builders hope that the supreme test will never come.

The five battleships laid down in 1937 are uniform in type, with a standard displacement of 35,000 tons. This means that when ready for sea their weight will exceed 38,000 tons. On paper their armament of 14-in. guns may compare ill with the heavier weapons of contemporary foreign units, but the new 14-in. gun is a rapid-fire, hard-hitting weapon which can engage effectively at all practicable ranges. By adopting it in preference to a heavier caliber the designers have saved about 30 per cent in total weight. Part of this economy has been devoted to speed, but most of it to protection. For obvious reasons one must not particularize, but it is permissible to say that the new British battleships will be as hard to sink as any now afloat or building—and perhaps harder. In the next group of five ships, probably to be laid down in 1938-39, guns of 16-in. caliber may be mounted. Concurrently with this new construction a great program of modernization is under way. Five older battleships and three battle cruisers have been practically rebuilt at an average cost in excess of £2,000,000, and a whole fleet of cruisers is undergoing the same process. The intention is to have ready by the year 1941 a force of not less than 25 capital ships, sufficient to provide squadrons for the Atlantic, the Mediterranean, and the Far East.

Of special significance is the Navy's intensive development of its air force. At the present time five airplane carriers—one of 22,000 tons, the others of 23,000 tons—are building, to accommodate a total of 350 planes. Older carriers, such as the *Furious*, *Courageous*, and *Glorious*, are being modernized. Eventually the Navy will possess ten effective carriers housing well over 500 planes. Now that the Fleet Air Arm has been freed from the hampering effect of dual control, the task of co-ordinating sea and air power has become simpler. There is reason to hope that in a few years the British naval air service will be the second strongest in existence, outnumbered only by that of the United States.

As recently as 1933 the British Commonwealth had only 15 cruisers of postwar design completed. By 1941-42 there will be 60 of these ships in service, besides 10 older cruisers modernized

and rearmed. This force of 70 units is regarded as a minimum which must be increased in the event of a marked revival of cruiser building abroad. A feature of the reconstruction program is the conversion of seven old cruisers into anti-aircraft ships by arming them exclusively with high-angle guns. Further, a number of the sloops now building (known as " escort vessels ") are to mount only high-angle guns. In the same connection all new capital ships and cruisers, as well as all modernized ships, are being equipped with very powerful batteries of long-range anti-aircraft guns and multiple machine-guns.

Up to and including 1935, the annual program never included more than nine destroyers, these boats averaging 1,350 tons. In the last two programs provision has been made for a total of 40 destroyers, averaging 1,730 tons. Further, the yearly quota of submarines has risen from three to seven. Escort vessels, patrol gunboats, minesweepers and auxiliaries of every type are also being built in large numbers.

Swift Progress Made

One of the surprising features of this great naval rearmament movement is the speed and smoothness of its progress. It was inaugurated at a time when, as the result of years of depression, the shipbuilding and armaments industries were at a low ebb and carrying on with a skeleton staff of technicians and skilled workers. In these conditions it seemed impossible that Britain's new fighting fleet could be built and equipped without inordinate delay, and even then only at the cost of dislocating other branches of national industry. Nevertheless, the impossible has been achieved. In place of delay, warships of every type are being built far more rapidly than was previously the case, and to-day the program as a whole is well ahead of schedule. Nor has there been any serious dislocation of other industries apart from mercantile shipbuilding, the cost of which has risen sharply as the result of the Navy's priority demands on steel supplies and the skilled labor market. Once again a sudden emergency has revealed the immense economic and industrial resources at the command of Britain, and not less the national genius for mobilizing those resources and exploiting them to the full when the need arises.

It has already been stated that the personnel of the Navy has in recent years been increased from 98,000 to 112,000 and will be further enlarged to 125,000. Despite the counter-attraction of the Air Force, which in all countries seems to make a special appeal to youth, recruiting for the Navy continues to be brisk. In the current year the Navy's manpower potential has been reinforced by the institution of a supplementary reserve of officers drawn from the yachting community. This reserve has already reached a strength of 1,000. Further, the Admiralty recently undertook the training of merchant service officers in war defense duties, and schools for this purpose have been opened at all the principal ports. There the officers are taught how to defend their ships against attack by surface raiders, submarines, aircraft and mines. Large stocks of efficient guns are held by the Admiralty in readiness for mounting on board British liners and cargo vessels in the event of war. In consequence of these measures British shipping to-day is much less vulnerable to attack than it was at the beginning of the World War. It is known, too, that detailed plans have been prepared by the Admiralty for the protection of shipping in war. The machinery for introducing convoy on all the important routes has been set up, and is ready to be put in motion by a stroke of the pen. Although the writer does not share the optimistic view that submarines are no longer a serious menace, he has reason to know that the offensive powers of this weapon have been circumscribed by recent advances in anti-submarine tactics. To what extent aircraft constitute a menace to merchant shipping it is impossible to decide. The British naval view is that merchantmen will have little to fear from air attack while they are at sea, particularly if they carry one or two high-angle guns. On approaching port they would be escorted by naval vessels mounting strong anti-aircraft batteries, as well as by fighter planes from shore bases. The worst danger to merchant ships is likely to come when they are loading or unloading in docks which are within range of hostile bombers. The problem of defending them in these conditions is, however, one for the British Air Force, and hardly concerns the Navy.

As the British Navy is now entirely an oil-burning organism, and only seven per cent of Britain's oil supplies is produced at home, it follows that an uninterrupted flow of oil from overseas is an essential condition of national security. The naval authorities, possessing knowledge withheld from the public, are confident that adequate supplies will be forthcoming. Meanwhile, very large reserves of the precious fuel are being accumulated within Great Britain and at all oversea bases of strategical importance. It is believed that the Commonwealth is already stocked with oil sufficient for a war of twelve months' duration. If by that time the Navy had found it impossible to maintain the requisite volume of imports into the country, the oil problem would be overshadowed by the larger one of obtaining the best peace terms.

Although the task of surveying and modernizing the British Navy's world-wide lines of communication had been undertaken long before the Mediterranean crisis of 1935-36, that event led to the process being speeded up considerably. In particular, the threat to the commercial route through the Mediterranean encouraged the development of harbor and dock facilities along the eastern and western coasts of Africa. Mention has been made of the great scheme of port development now being carried out at Cape Town. Nearby is the naval base of Simonstown, which the Union Government places at the disposal of the British Navy. This station is also being brought up to date. But if the Mediterranean route is liable to become too dangerous for merchant shipping in wartime, Britain has not the least intention of resigning its strategic control to other hands. It was announced in Parliament on November 3 that the defenses of Malta are being rapidly improved. Both Admiralty and Air Ministry have an eye on Cyprus, the development of which as a first-class aero-naval base appears to be assured. Further, unless Anglo-Italian tension is sensibly eased during the next twelve months, the dispatch of heavy reinforcements to the Mediterranean naval and air formations and military garrisons is practically certain to take place. All this activity expresses the British people's firm resolve not to be hustled out of a sea where freedom of movement is of great importance to the security of the Commonwealth as a whole.

In conclusion it may be affirmed that Britain can face the future with calmness and confidence. Though much remains to be done, the most serious gaps in her defenses are now filled. As the rearmament program approaches maturity her powers of defense and counter-attack, already formidable in Europe, will be projected further afield, and knowledge of this fact is quite likely to have a sobering effect on those foreign states whose sabre-rattling propensities have been encouraged by the apparent growth of pacifism among the British peoples. It is gratifying to be able to record, not as a sentimental flourish but as simple truth, that British opinion sees in the growing naval power of the United States an additional and complementary guarantee of world peace.

Development of the Open Door Policy in China

(Continued from page 44)

The Hirota pronouncement of May 1, 1934, may further elucidate these points:

> " Japan sincerely desires the preservation of territorial integrity of China and her unification and prosperity. These ends should, fundamentally speaking, be attained by China herself through her own awakening and voluntary efforts.
>
> " Japan has no intention to trespass upon the rights of other Powers in China. Their *bona fide* financial and commercial activities will redound to the benefit of China which is quite welcome to Japan. She, of course, subscribes to the Principles of the Open Door and Equal Opportunity in China. She is observing scrupulously all existing treaties and agreements concerning that country.
>
> "However, Japan cannot remain indifferent to anyone's taking action under any pretext, which is prejudicial to the maintenance of law and order in East Asia for which she, if only in view of her geographic position, has the most vital concern. Consequently she cannot afford to have questions of China exploited by any third party for the execution of a selfish policy which does not take into consideration the above circumstances."

We can all be helpful to China, if China does not single out a country as an object of her national policy. We all are hoping for economic co-operation with China, for a stabilized and rich China would prove to be a dependable and good customer. Others can afford to be idealistic, even luxurious in their sentiments. But as for Japan, she is too closely and intimately involved with China, and cannot afford to have any other policy except that of "live and let live" and " co-existence and co-prosperity," not sporadically but all the time. Such a policy can hardly ever be an isolated existence.

Railways and Railway Ports of the Federated Malay States

THE year 1936 saw the Federated Malay States Railways restored to a condition of solvency. The General Manager, Mr. D. H. Elias, C.M.G., M.C., makes this gratifying announcement in his annual report, a review of which is given in the July number of *Eastern Engineering and Commerce*. The depression which began in 1930 resulted in a succession of very lean years, but 1936 turned the scale with earnings of over thirteen million dollars and an excess of revenue over expenditure of over $2,700,000, this enabling the renewals fund to be considerably enhanced and a small dividend to be paid to the Federal and Johore Governments. The review of the report given by *Eastern Engineering and Commerce* continues as follows :

Than the Federated Malay States Railways there is no more important undertaking in Malaya. With headquarters at Kuala Lumpur, the system operates throughout the Peninsula, and makes possible much of the prosperity which is enjoyed to-day. Development of both the tin and rubber industries, life-blood of Malaya, largely follows the railway track, which, running north from Singapore, cuts straight through the heart of the country to the east coast at Tampat, Kolantan, and on to the border of Siam at Sungei Golok, 580 miles from Singapore, while on the west coast it feeds the highly-developed areas of Negri Sembilan, Malacca, Selangor, Perak, Province Wellesley, Kedah and Perlis. At various points lines branch off to tap the harbors of Malacca, Port Dickson, Port Swettenham, Teluk Anson, Port Weld, and Prai. Altogether there are 213 stations and 80 halts in use. Turning to the report of Mr. Elias, we find that during 1936 the engines travelled 5,162,002 miles, an increase of 296,193 miles over 1935, and that in order to do this they consumed 155,138 tons of coal. Passengers to the number of 6,873,055 (excluding seasons) travelled during the year, an increase of approximately 700,000, and although there were 49 fatal accidents (railwaymen and trespassers) and 89 derailments, not a single passenger was involved. It provides a thrill to read that railway property on the east coast line was raided on ten occasions by wild elephants with considerable damage, and that a fully-grown tigress was run down and killed in a tunnel on the same line. One has read of the monotony of travelling through miles of rubber plantations, but such opportunities for a close-up view of the fauna of Malaya dismiss complaint. Although there was less revenue for more passengers carried, goods traffic appears to have jumped with a bound, there being increases of 28.68 per cent in tonnage and of 22.78 per cent in earnings. It is still necessary to undercut the competition of road vehicles, and the increased revenue was obtained despite the fact that the average freight was only $3.88 per ton, as against $4.05 in 1935 and $4.36 in 1934. A special feature of the 1936 freightage was the expansion of bulk latex and palm oil. The railways provided 27 bulk latex wagons and 32 bulk palm oil wagons in 1936, and more are being built. The total paying goods traffic, excluding livestock, was 1,660,427 tons, as against 1,290,371 tons. The coal carried was 483,338 tons, against 356,660 tons, there being an increased demand from the tin mines.

At the close of the year there were 163 locomotives and six articulated sets of rail motor coaches. The cost of fuel was less than the previous year at 16.57 cents per engine mile. The oil consumption revealed a slight increase, partly due to a less number of smaller type locomotives in service. These smaller locomotives are being replaced by larger types, hauling larger loads. Under the heading of "Maintenance of Way and Works," it is stated that very satisfactory progress was made during the year on the reconditioning of points and crossings *in situ* by means of electric arc welding. Timber sleeper requirements, nearly 300,000, were purchased locally, but as there are indications of a shortage of local hardwood, it is proposed to use a percentage of impregnated semi-hardwood. In this connection an impregnating plant to treat about 25,000 sleepers annually is in course of installation. The steel-work of 130 bridges was painted during the year, and that of 132 bridges patch-painted. Judging from details given in the report, all wharves and jetties, station buildings, quarters, sheds, workshops, the railway itself and its rolling stock were maintained in good condition. The total stock of locomotives at the end of the year was 169 : seven had been condemned during the year, and none purchased. Of bogie coaching vehicles there were, at the end of the year, 360, of other coaching vehicles, 150, bogie goods stock 393, and of four-wheeled goods stock 5,193. Eleven vessels, three at Prai, five at Port Swettenham, and three at Kota Bharu, maintained the passenger ferry and tug service. There were besides 68 steel and 11 wooden lighters.

One of the latest F.M.S. railway locomotives

Ports

Details are given in the report of tonnage handled at ports in Malaya. The two principal ports, which are administered by the Singapore Harbor Board, are, of course, Singapore and Penang. At Singapore the majority of ocean-going vessels are berthed at the Harbor Board's wharves, where facilities are provided for the rapid handling of cargo, bulk latex and palm oil, and for oil and coal bunkering. The wharves are 10,709 feet in length, including 4,412 feet at which the depth of water at low tide is 33 feet and over. A further length of deep water wharf, totalling 2.454 feet, on which a mechanical coal handling plant is to be erected, is under construction. Steamships of 42,000 tons register can approach the wharves at all stages of the tide. Vessels can load and discharge in the inner and outer harbor. Singapore is a free port, there being no port, harbor, dock, town or light dues.

At Penang, Swettenham pier, 1,200 feet long, with a minimum depth of 30 feet at low water, is used principally by large liners. Other vessels anchor in the harbor, loading and unloading by means of lighters. The Penang Harbor Board possesses 17 steel and 92 wooden lighters and godowns space. Penang also is a free port. There are seven ports administered by the Federated Malay States Railways. Prai is situated at the mouth of the Prai river, running into Penang harbor. Length of wharf frontage is 3,827 feet six inches, and the depth of water over the bar at the mouth of Prai river is 16 feet at low water.

There are seven ports administered by the Federated Malay States Railways. Chief of these is Port Swettenham, which last year handled, besides smaller craft, ocean vessels to the number of 1,027. Here there is a 1,008 feet wharf, with berthage for two ocean vessels, also two wharves for coasters. The depth at low water is 31 feet. The wharves are equipped with four three ton and one five ton steam cranes, and with four two ton and one five ton electric cranes. A travelling 20 ton steam crane is available for lifts above five tons. Lifts up to 35 tons can be dealt with. There are 77 lighters and three lines of railway on No. 6 wharf so that cargo can be handled direct between ship and wagons.

Sixteen godowns are available with road access.

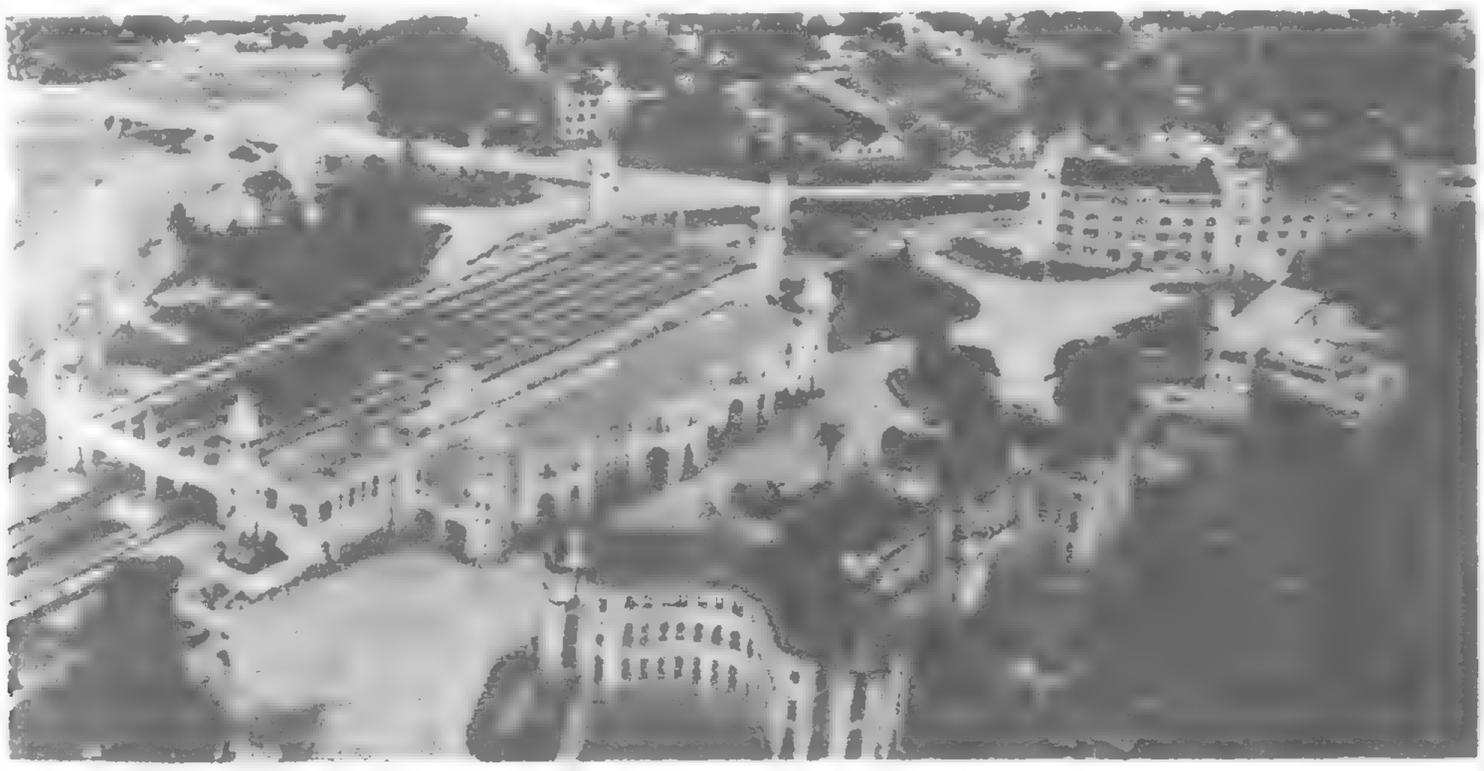
Of Port Weld, Teluk Anson, Port Dickson, Malacca, and Tampat, the report says little, but all serve a useful purpose in handling the growing trade of Malaya, and assisting the Railway. Of the Port of Prai, at the mouth of the Prai River, running into Penang harbor, it has often been described as a "white elephant." This, declares Mr. Elias, is quite wrong. In support of this view he says Prai affords an excellent lighterage port, which is busily and efficiently employed in shipping and receiving rail cargo. From an engineering point of view it is possible to provide Prai with a deep water berth. There is now 30 feet at the wharf, with 16 feet over the bar at the mouth of the Prai River. It is considered that a dredge could maintain a depth of 30 feet over this bar, but whilst the main shipping and commercial interests at Penang oppose a transfer to Prai of any ocean shipping business, it is inadvisable to undertake these dredging operations. In 1935 it was necessary to build an additional godown on the wharf, and in 1936, 54,661 tons were received by rail at the wharf and 86,852 forwarded by rail. This shows increases of approximately 15,000 and 31,000 tons respectively. In 1932 a temporary groyne was constructed at the Prai river bank, opposite the wharf, running 1,452 feet into the sea. When it was seen that a satisfactory scour was secured at the river mouth, arrangements were made to construct a permanent groyne alongside the temporary one. This permanent groyne, consisting of a sea-wall of heavy granite blocks with a rubble core, of the same length as the temporary structure, was practically completed at the close of the year under review. It is proving effective in maintaining a navigable channel 120 feet wide and 16 feet deep. The lighterage wharf at Prai experienced its busiest year in 1936. A few ocean-going steamers and coastal vessels berthed there during the year. The length of wharf frontage is 3,827 feet six inches, and the depth over the bar at low water is 16 feet. The wharf is equipped with three electric cranes—one of seven tons and two of three tons—and four steam cranes—one of 20 tons, one of five tons and two of three tons. There are also eight electric capstans and six electrically-operated turntables. Five godowns are available, with an area of 52,925 square feet. Cargo from ocean-going ships is lightered. Ocean-going ships, except of a small type, do not come alongside Prai wharf. There is no direct road access to the wharf.

View of the Johore Causeway

Returning to the financial side of the undertaking, Mr. Elias says the results of 1936 are satisfactory. If the Pahang and Kelantan sections of the East Coast Railway, with their heavy deficits, could be excluded, a substantial increase would result. The revenue surplus was $2,774,357, and is thus disposed of : due to Renewals Fund, $1,927,045; due to Federal Government, $760,612; due to Johore Government, $86,700. The Federal Government surrendered its proportion of the surplus to the Renewals Fund, and also contributed $1,000,000 to this Fund. In addition, the Fund received $226,297 from interest on investments. This Renewals Fund stood at $11,676,571 at the close of the year, and now begins to assume a healthy aspect.

The question of writing down the capital of these railways has often been under discussion, and time to time comparatively small amounts have been written off. During 1936 a thorough investigation of the subject was made. As a result, it was found that the Capital Account, which stood at $235,249,526 at the close of 1935, was encumbered with abandoned assets to the extent of $8,090,734. This amount was written off in 1936.

The total revenue earned during the year was $13,086,733, which is $1,215,636, or 10.24 per cent in excess of the preceding year. The total expenditure, excluding provision for renewals, was $10,312,376, which is $215,035, or 2.13 per cent in excess of expenditure during the preceding year.



Aerial view of the F.M.S. railway headquarters and station at Kuala Lumpur

Stag Allente Tungsten Carbide Tools

Since Edgar Allen & Co., Ltd., introduced Stag Allenite new patented tungsten carbide tipped tools, numerous reports have been received from various works in which they have been thoroughly tested. In one such instance, they were tested on nickel iron of 50 tons tensile strength, Brinell hardness 250. The tool was reported to have stood up to this work exceedingly well. It finished the large bore of brake drums for a well-known type of automobile at finishing speed of 316-ft. per minute, with approximately 80 cuts an inch. The machines in which this tool was used were very modern semi-automatic chucking machines tooled and operated for maximum production of front axle assemblies of two popular cars. As these assemblies are produced in large quantities, the tool was given a complete test under the most modern conditions. In another instance, a Stag Allenite tool turned approximately 400 components in cast iron, inclusive of planing 35 components. At these works a test was run on 25 castings 4-in. diameter with intermittent cutting at 220-ft. per minute. The tool at the finish did not require any sharpening.

Recently a group of mines decided to carry out extensive tests under normal conditions with drill steel of the same composition made by two large manufacturers, one of whom was Edgar Allen & Co., Ltd. The tests were extended over two months to obtain decisive results. At the end of the test the records showed that Stag brand mining drill steel had given an average of 4-in. per drill greater penetration than another steel having the same composition.

New German Airplanes

By Dipl. Ing. E. BERENDT VDI, Berlin in Engineering Progress

GERMAN aircraft manufacturers have brought out a large number of new models within the last months. New machines have been developed for every purpose: for long-distance flying, travel, instruction, practice, and for the air force. With a new type of autogiro, revolutionary advances in performance have been realized.

Science and engineering alike have contributed to promote German aircraft construction. The performance of the new planes are such as to meet even the highest expectations. In all of them the greatest value has been accorded to safety and reliability. Development has therefore tended towards bi-motored touring planes and four-motored traffic and long-distance planes.

Long-Distance Planes

The "Hamburg Ha 139".—The Hamburger Flugzeugbau G.m.b.H., an affiliated company of the world-renowned German shipbuilding firm of Blohm & Voss, recently brought out a four-motored seaplane. This craft has been developed for the Deutsche Lufthansa and is intended for use in the regular flying service scheduled between Germany and North America, on which the plane is to cover part of the stretch across the Atlantic.

The "Hamburg Ha *139*" is a cantilever monoplane, Figs. 1 and 2, which shows novel design features all the way through. The dented single wing contains but one spar, which is of tubular form. Built into the wing are the four engines, which give a total output of 2,400 h.p. They are water-cooled six-cylinder Junkers Diesel engines Type "Jumo 205 C." The wing is of uniform depth. The fuselage is circular in cross-section and of all-metal monocoque design. It provides room for a crew of four men, in addition to a freight space 3.5 m. (11.5-ft.) long and of a content of 6.5 cu.m. (230 cu. ft.). The tail unit consists of a braced stabilizer and two circular fins. The ailerons can be adjusted during flight. Below the inside engines are arranged the floats, which are supported without bracing, the tubular carrying members being flanged to the wing spar.

The "Ha 139" attains a maximum speed of 300 km. (185 miles) per hour and has a travelling speed of 250 km. (155 miles) per hour. A total of 6,600 l. (1,450 Imp. gal.) of fuel can be accommodated in five compartments in the central portion of the wing spar. In this manner, the usual separate fuel tanks are dispensed with and weight is accordingly reduced. With the fuel quantity referred to, the machine has a range of 5,000 km. (3,100 miles).

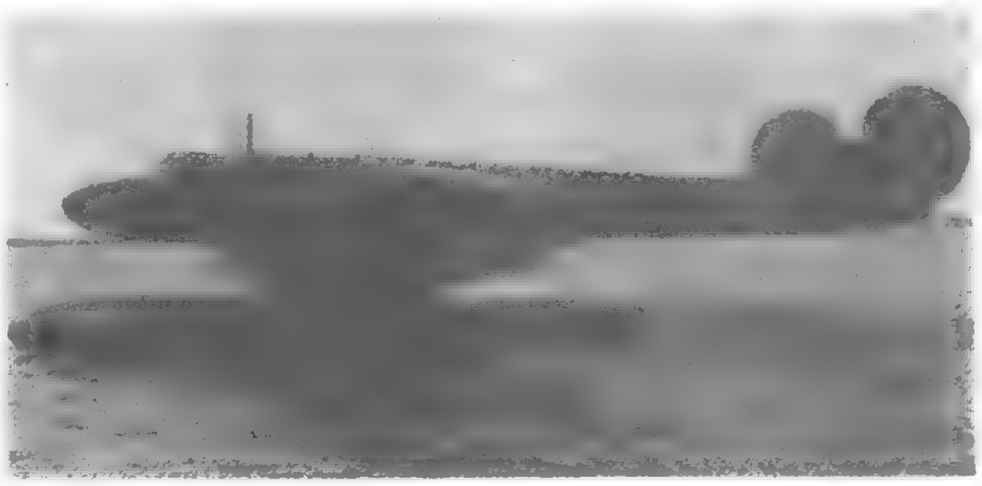
The sea qualities of the plane are very good. It is able, for example, to rise clear of the water in less than thirty seconds when loaded with a flying weight corresponding to a range of 3,500 km. (2,200 miles). In the event of failure of an engine, the flight can be safely continued with three engines with full flying weight. Even with two engines, it is possible to continue with reduced flying weight. Accordingly this model of the Deutsche Lufthansa represents a machine offering the, at the present, maximum measure of safety for the flight across the North Atlantic.

The "Friesenland" Floating Airplane Base.—As has been mentioned, the "Ha 139" long-distance airplane is to be used by the Deutsche Lufthansa on regular schedule across the Atlantic. For this purpose, a fourth floating airplane base, the M.S. *Friesenland*, Fig. 3, was recently started into service. While the two first floating airplane bases, the *Westfalen* and *Schwabenland*, were rebuilt freighters, the third vessel, the *Ostmark*, and again this fourth, the *Friesenland*, have been expressly built for the purpose by the Howaldtswerke, of Kiel. This fact becomes at once evident from the outward appearance of the ship. For, since the greatest practicable deck space is required for catapulting the planes, all superstructures as well as the engine room and the funnel have been concentrated at the fore end. The *Friesenland* was from the outset designed for service on the North Atlantic, and is therefore larger and more seaworthy than its predecessors. The ship is 138.0 m. (455-ft.) long by 16.5 m. (54-ft.) wide, and has a draught of 6.0 m. (20-ft.) Its measured displacement is 6,500 gross register tons. Two M.A.N. Diesel engines each of 2,500 h.p. give it a speed of 16 knots.

The *Friesenland* is to aid the "Ha 139" in starting. To accomplish this end, a large-capacity catapult designed for impelling a weight of 17 tons was built by the Ernst Heinkel Flugzeugwerke, of Warnemünde. The catapults of the other airplane bases are only calculated for impelling 10 tons. The planes are launched over the stern of the ship. They are likewise hoisted on board over the stern, by means of a 20-ton crane built by Kampnagel, of Hamburg, who also furnished the aircraft transporting plant on the vessel.

The fuel plant, which was supplied by Martini, Hünecke & Salzkotten, of Salzkotten, is of special importance because the ocean airplanes must be fuelled at a point far from home. For this purpose, ten tanks of a total capacity of 227,000 l. (50,000 Imp. gal.) are provided. For the machinery installation of the vessel itself, eleven further tanks, capable of holding 2,383 tons of crude oil, are available.

The wireless installations are products of the Debeg (manufacturers Lorenz and Telefunken, both of Berlin). Finally, the Hein drag sail, for assisting in taking the plane aboard, and built by Beilken, of Vegesack nr. Bremen, should be mentioned.



Figs. 1 and 2.—"Hamburg Ha 139" long-distance plane with four junkers "Jumo 205 C" Diesel engines

Hamburger Flugzeugbau G.m.b.H., Hamburg.

Weights:—
Weight, empty.. 10 tons
Disposable load 6 tons
Weight, loaded 16 tons

Dimensions:—
Length .. ..19.5 m. (64-ft.)
Span .. ..27.0 m. (88.5-ft.)
Wing area ..117.0 sq.m. (2,270 sq. ft.)

Performance:—
Maximum speed 300 km. (186 miles) p.hr.
Cruising speed..250 km. (150 miles) p.hr.
Landing speed..100 km. (62 miles) p.hr.
Climb to 1 km. (0.6 miles) 6 min.
Service ceiling..3.5 km. (11,500-ft.)
Range .. .. 5,000 km. (3,100 miles).

Engines:—
Water-cooled six-cylinder-in-line, two-cycle Diesels, opposed-piston type.
Compression ratio: 1: 17.
Weight per engine, without water, oil, and hub, ready for operation 520 kg. (1,150 lb.).
Total piston displacement per engine 16.62 l. (1,020 cu.in.).
Normal output per engine 510 h.p. at 2,200 r.p.m.
Fuel consumption per engine 165 gm. (0.365 lb.) p. h.p.-hr.
Lubricant consumption per engine 8 to 12 gm. (0.018 to 0.27 lb.) p.h.p.-hr.

First North Atlantic Flights of the Deutsche Lufthansa in 1937

The flights across the North Atlantic successfully inaugurated by the Deutsche Lufthansa in 1936 are being continued this year. The first flight was from Travemünde, Germany, to New York with the "Hamburg Ha 139" four-engined long-distance plane, in a pure flying time of 33.5 hours. The route followed was via

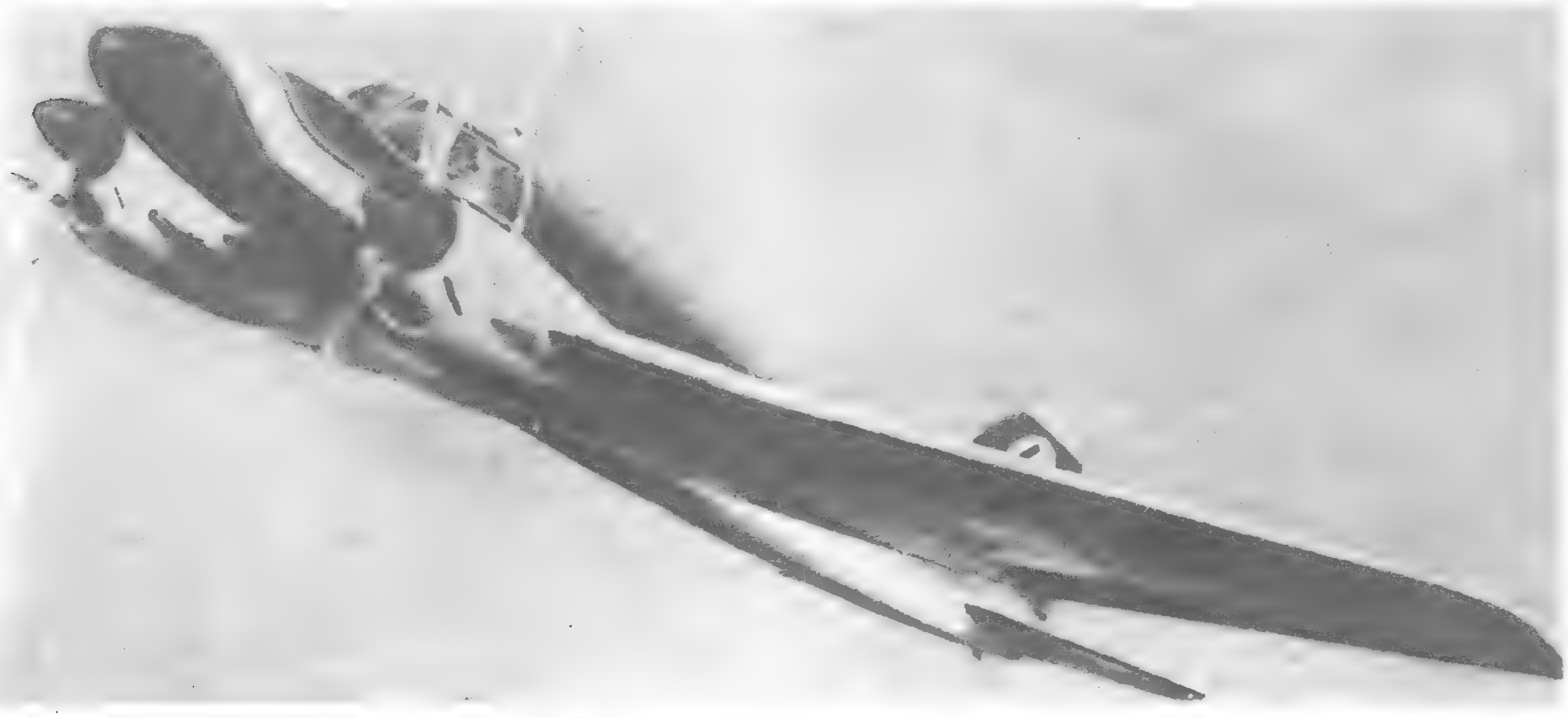


Fig. 4—" Der Kurier " model AO 192

Lisbon and the Azores. Additional going and return flights were in the sequence successfully carried out.

Since the Junkers " Jumo 205 C " Diesel aero-engines with which the plane was equipped each consume 36 kg. (80 lb.) of fuel per hour less than a gasoline engine of equal power, the saving in fuel obtained at this rate with four engines and a flying time of 35 hours amounts to over 5,000 kg. (11,000 lb.).

This machine is an example of the large economic superiority of the Diesel airplane engine particularly in long-distance flight, apart from and additional to its other numerous advantages. It should be mentioned in this connection that in the whole world, the sole and only Diesel airplane engines so far in successful use on regular schedule are those of the Junkers Flugzeug- und Motorenwerke A. G., Dessau.

Touring Planes

The AGO—Flugwerke G.m.b.H. recently brought out the first model, the Ao 192 " Kurier " airplane, built to their own designs. The machine is a two-motored, cantilever low-wing plane, Fig. 4, for six to eight persons including the crew, and makes an excellent impression externally.

The two engines are accommodated in the central portion of the three-part wing. They are air-cooled Model As 10c " Argus " motors of a combined continuous output of 400 h.p. at 1,880 r.p.m., built by the Argus Motoren G.m.b.H. of Berlin-Reinickendorf. The center portion further contains the landing gear. The tips are each fitted with an aileron and an automatically acting Handley-Page slot wing.

The fuselage is of monocoque construction. The landing gear is retracted during flight by an oil-hydraulic gear.

The pilots' seats and the passengers' seats are accommodated in a single space without fixed division. Access to the pilots' seats is by way of the wing by turning up that portion of the cowling containing the side window. For the passengers, a door is provided in the right side of the body. The cabin is comfortably and practically arranged. Above each seat is a reading lamp. The room is ventilated and heated and may be used to smoke in. Located behind the cabin is a baggage room, which is disposed and arranged to allow the passengers to get at their luggage during flight. A second and larger baggage room is located in the end of the hull.

The passenger seats may be removed at any time, so that the plane can be used for the transportation of freight. A very roomy freight space can be provided in this manner.

" *Gotha Go 146.*"—A fast and efficient German touring and courier plane is the " Gotha Go 146 " of the Gothaer Waggonfabrik A.G., Fig. 5. The machine is fitted with two Model H M 508 air-cooled cylinder-in-line engines of the Hirth Motoren G.m.b.H. of Stuttgart-Zuffenhausen. The continuous output of these engines is 200 h.p. Other engines ranging from 180 to 280 h.p. capacity may be installed.

The machine is a cantilever low-wing plane with retractable landing gear. It is designed for four persons including the pilot and wireless operator. Particular care has been taken to ensure the comfort of the passengers. Accordingly there are provided, among other things, a well-arranged illumination and a hot-air heating plant. The visibility from the plane is excellent. Adequate stowing spaces are available for the baggage. The instrument, wireless, and bearing-finding equipment and the devices for the safety of the passengers and crew satisfy the demands made to-day of a high-grade touring plane.

The fuselage is of oval section and of all-metal monocoque construction. Entry into the cabin is through two trap doors. The wing is of the dented type. It has two spars and is of trapezoid form. Slot landing flaps ensure good starting and landing qualities.

Fig. 3—" Friesenland " airplane base of the Deutsche Lufthansa
—Howaldswerke A.G. Kiel

Halle Model " Fh 104."—A further fast bi-motor touring plane is built by the Flugzeugwerk Halle G.m.b.H. This machine attains a maximum speed of 335 km. (205 miles) per hour: at the continuous combined output of the engines, of 340 h.p. the touring speed is still 300 km. (185 miles) per hour. This good performance is due to the careful design and construction of the entire machine. The landing gear is retracted during flight.

In consonance with its duty as a touring plane, the machine is equipped with a wireless set for long and short waves, as well as with one fixed and one trailing antenna. In connection with the complete night and

Fig. 5—" Gotha Go 146 " touring plane with two model HM 508 Hirth engines—*Gothaer Waggonfabrik A. G., Gotha*

blind-flying equipment provided, these installations ensure safe flying at all times of the day and in bad weather.

The new model, Fig. 6, is designated " Fh 104." It is of the cantilever low-wing type. The cabin, Fig. 7, offers room for five persons. Adequate space is provided for luggage. Two large doors afford convenient entry. The cabin is lighted, well ventilated, and heated. Soft leather-upholstered seats make for comfort in travel.

The materials used in the plane are the Dural alloy of the Dürener Metallwerke A. G., Berlin-Borsigwalde, and wood. In other words, the so-called mixed construction has been preferred. The ailerons and landing flaps are hydraulically operated with the aid of a push-button control. A safety device automatically acts as soon as the landing speed exceeds 160 km. (100 miles) per hour by reducing the deflexion of the ailerons.

The landing gear has a wheel gauge of 3.44 m. (11.3-ft.). Each half of the landing gear is hydraulically folded backward into extensions of the engine nacelles. Operation is made easy by a push-button control. The landing gear is retracted in five to seven seconds and extended in two seconds. In the end positions, the gear is automatically held latched. A Bosch signal horn sounds whenever the engines are throttled, and ceases sounding only when the landing gear has been completely extended.

The airscrews are two-bladed, and can be set to the desired lead on the ground. They are of the light-wood-jacketed type and are products of the Propellerwerk Schwarz, Berlin.

Fig. 6—" Fh 104 " touring plane with two model HM 508 Horth engines—*Flugzeugwerk Halle G.m.b.H., Halle a.d. Saale*

War Planes

Focke-Wulf " Weihe " Model Fw 58 B.—We shall first consider a multiple-purpose training plane built to meet the most stringent demands of military air training. This is the " Weihe " Model Fw 58 B of the Focke-Wulf Flugzeugbau G.m.b.H., which has been evolved from the Model " Fw 58." The new model is particularly intended for re-training pilots in handling large aircraft with dual controls ; for wireless schooling ; training in blind and night-flying ; and for machine-gun and bomb-throwing practice.

In the new " Fw 58 B," Fig. 8, the open-nose cockpit for the marksman of the earlier Model " Fw 58 " is changed into a closed prow of careful aerodynamic design, which, together with the improved form of the pilot's room cowling, considerably betters flying performance. By the extensive use of Plexiglas, conditions of sight for the machine-gunner or bombing marksman have been rendered extremely favorable. The machine-gun is operated with the gunner in a prone position. For training in bomb-dropping, additional space is provided in the prow for an instructor. The bombing sight is plainly visible in Fig. 8. When not in use, the bombing sight is protected by a flexible sliding cover.

Fig. 9 conveys an idea of the good aerodynamic design of the entire plane. The rear machine-gun station is not completely inclosed, inasmuch as it is well protected by the pilot-room cowling. The machine-gun is mounted on a pivot ring.

Conversion from one use to another can be quickly and easily effected. It should be observed in addition that this model is well liked as a touring, mail, and feeder plane in Germany as well as abroad.

Dornier " Do 22."—A further multiple-purpose plane is the " Do 22," Fig. 10. of the Dornier-Metallbauten G.m.b.H. This machine can be used as a seaplane for long-distance scouting, as well as for bomb and torpedo throwing. The crew consists of three men, the pilot, the observer, and the gunner, who sit in line behind one another. The plane is of the braced high-wing type and is especially notable for the arrangement of the floats. The float frame is so connected with the wing bracing as to leave the space below entirely free for the suspension and launching of the torpedo and bombs. The floats are from light metal and are each divided into nine watertight compartments, which ensure continued floating even with damaged floats.

The wing is of back-swept and slightly vee-shaped form. It is provided with ailerons with internal compensation, which are made to serve as landing flaps by the addition of a special device. The control gear is remarkable for the fact that the tailplane can be adjusted during flight for compensating for changes in load.

The crew is charged with the following duties : The pilot also operates the fore gun, which fires through the propeller circle. The observer is provided with an auxiliary steering gear for use in the event of disability of the pilot. He takes care of the wireless and of the camera and operates the bomb-dropping installation, in which latter case the camera is replaced by a bombing sight. The gunner has a twin machine-gun mounted on a pivot ring. He defends the machine against attack from the rear and downward to the rear. For this latter purpose, a second machine-gun is provided, which is discharged through a firing channel.

A 700-to 900 h.p. engine lends the plane a maximum speed of 320 to 325 km. (about 200 miles) per hour, while the landing speed is but 82 km. (50 miles) per hour.

Arado " Ar 95."—A further new design in this field is the " Ar 95 " multiple-purpose plane of the Arado Flugzeugwerke G.m.b.H. of Nowawes nr. Potsdam. It is intended for both sea and land use, for the duties of scouting in artillery observation, fogscreening, bombing and torpedoing, as well as for towing targets in anti-aircraft practice.

Fig. 11 shows the machine in the form of a seaplane. As will be seen, it is an all-metal braced biplane. The fuselage is of monocoque construction. It contains the seats for the pilot and the observer, both of which are covered with a Plexiglas wind shield of favorable aerodynamic design. The upper and lower wings can be folded down so that the plane only takes up a width of 5.80 m. (19-ft.).

The military equipment of the plane consists of :—

A machine-gun firing through the propeller circle, with 500 rounds of ammunition ; a swivelling machine-gun in the observer's

Fig. 7—Interior view of model " Fh 104 "

cockpit, with 600 rounds of ammunition; and a wireless combination sending and receiving set.

In addition, the machine can take :—

Six 50-kg. (110-lb.) bombs, hung from the lower wing; or a fog emitter weighing 375 kg. (830-lb.) attached to the fuselage belly; or

a torpedo weighing to 800 kg. (1,770-lb.), hung from the fuselage belly.

A camera or target-towing gear may also be accommodated.

The plane is strong enough to be launched by a catapult.

Henschel Battle Plane.—Particular attention is due to a single-seated fighter brought out by the Henschel Flugzeugwerke, Schöne-feld nr. Berlin.

The firm of Henschel & Sohn, Kassel, which celebrated its 125th anniversary in 1936, founded in 1933 at Schönefeld, near Berlin, an airplane plant which fully reflects in its arrangement and appointments the spirit of the parent enterprise. In the brief time since its inception, this new plant has clearly demonstrated its capability. At Schönefeld and in a branch works at Berlin-Johannisthal, exclusively all-metal planes are produced in large lots.

Figs. 8 and 9 Focke-Wulf "Weihe" model Fw 58 B multiple purpose training plane with two model As 10c "Argus" Engines
Focke-Wulf Flugzeugbau G.m.b.H., Bremen

The battle plane is of very good aerodynamic design and shows an exceptionally high strength. It is a cantilever semi-biplane, Fig. 12. The one-spar lower wing is continuous, while the two-spar upper wing consists of two sections, which are connected midways of the fuselage, and is supported by center-section braces and Y-stays. The upper wing contains the ailerons with weight compensation, while the flaps for reducing the landing speed are accommodated in the lower wing.

The fuselage is of monocoque construction, with longitudinal members and transverse ribs. Removable plates afford easy access to the lower portion of the body. The landing gear is directly applied to the lower wing. It is not retractable but is completely faired, at a considerable saving in weight. Springing is effected by means of so-called Uerdingen ring springs, with which the swivelling tail skid wheel is also fitted. The wheel brakes are actuated from the rubber pedal.

Focke-Wulf Model "Fw 159" Pursuit Plane.—New principles of design are also to be noted in a pursuit plane by Focke-Wulf, of Bremen, which was exhibited at the International Aeronautical Exposition at Brussels in 1937.

The machine is of the braced high-wing type. It has a water-cooled engine, which gives it a maximum speed of 410 km. (250 miles) per hour. The landing gear is unbraced and retractable. It folds in rearward, as may be plainly seen from Fig. 12, and in the folded position is completely covered by two lateral doors.

Dornier "Do 17."—A large multiple-purpose plane, the "Do 17," was developed for the air force by the Dornier-Metallbauten G.m.b.H. The plane was shown for the first time in public at the Fourth International Aviation Meeting at Zürich in 1937. On this occasion, the plane achieved a great success in the Alpine flight for military aircraft. The flying route was from the airport at Zürich

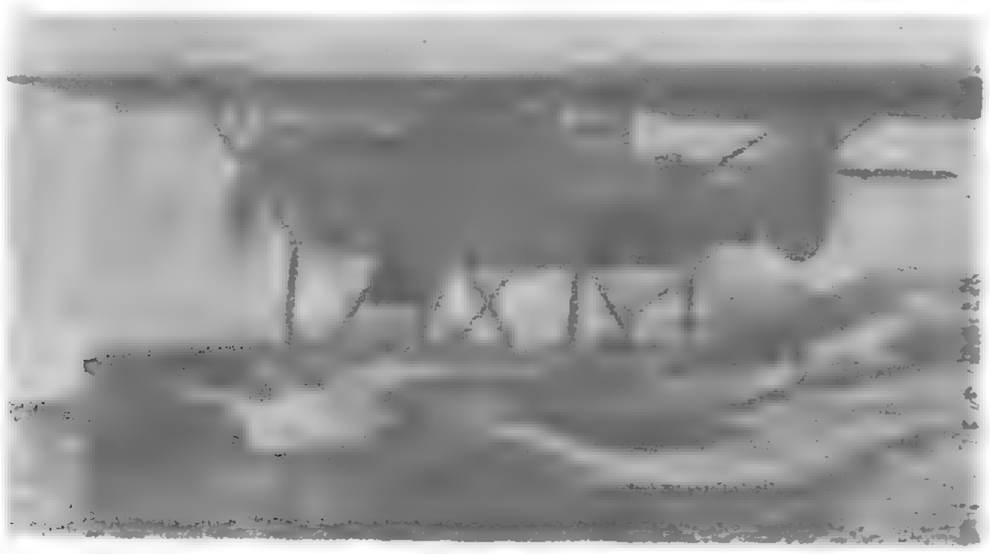


Fig. 10 Dornier "Do 22" multiple purpose plane
Dornier-Metallbauten G.m.b.H., Friedrichshafen am Bodensee

Fig. 12—"Henschel" single-seat dive bomber with "BMW 132A" radial engine and N.A.C.A. cowl

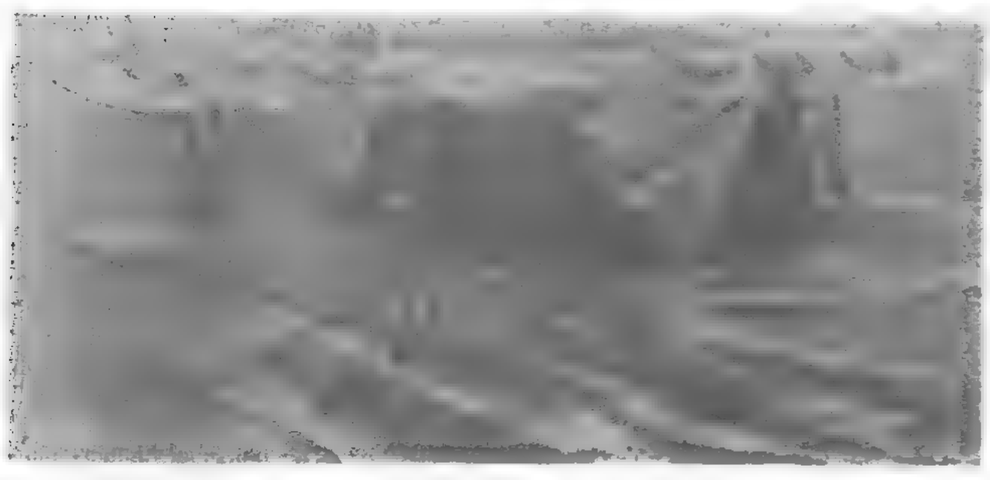


Fig. 11—"Arado Ar 95" multiple purpose plane equipped as seaplane with model BMW 132 De Radial engine by the Bayerische Motorenwerke

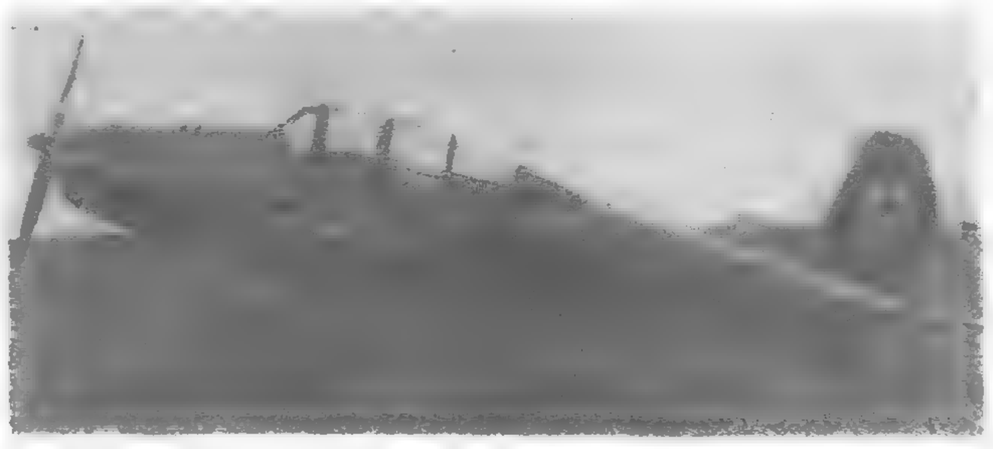


Fig. 14—"Arado Ar 96" multiple purpose training plane.—*Arado Flugzeugwerke G.m.b.H.*

by way of Thun to Bellinzona and directly back to the Zürich airport. In its class, the "Do 17" won in 58 min. 42.3 sec. The total length of the racing stretch was 367 km. (228 miles).

The plane is equipped with two engines. The landing gear is retractable, Fig. 13, and folds rearward into the engine nacelles.

Fig. 13—Dornier "Do 17" Bi-motored multiple service plane.—*Dornier-Metallbauten G.m.b.H., Friedrichshafen a.B.*

Training Planes

Arado Model "Ar 96."—The Arado Flugzeugwerke G.m.b.H, have developed an unbraced monoplane, Fig. 14, the Model "Ar 96." It is a multiple-purpose two-seater for plain and stunt flying, night-flying, machine-gun fire, bombing, photography, and also for flying to wireless signals. The wireless set is always available for both persons. In accordance with these duties, the plane is competent for every kind of areobatics.

The fuselage is of monocoque construction. It is of oval cross-section and is made from light metal. Both seats are protected by a cabin roof. For special training purposes, the roof can be easily shifted. The landing gear is retractable laterally into the wings.

Propulsion is by an air-cooled Model "As 10" Argus engine of a capacity of 240 h.p.

"Gotha Go 145."—The same training purposes are served by the Model "Go 145" two-seater of the Gothaer Waggonfabrik illustrated in Fig. 15. This machine is, however, of the biplane type and is of mixed construction. The landing gear is not retractable. It is of particularly rugged design, with a divided axle. The wheels are of elektron metal. They and the spring legs are products of the Elektron-Co., Stuttgart-Cannstatt.

Special Designs

Model "Fw 61" Autogiro.—The old problem of taking off and alighting in a vertical direction and of hovering in, or but slowly moving through, the air, has also been solved in Germany. The Focke, Achgelis & Co. G.m.b.H. recently demonstrated in public the "Fw 61" autogiro, Fig. 16, built by Prof. H. Focke. At this first demonstration, the craft succeeded in breaking all international records for this type of plane. It attained a greatest altitude of 2,500 m. (8,200-ft.), as against the record hitherto held by France, of 158 m. (520-ft.). The greatest duration of flight was one hour 20 min. 49.89 sec., against the previous record, held likewise by France, of one hour two min. 50 sec. Over a stretch of 20 km. (12½ miles), a speed of 122.553 km. (76.5 miles) was reached, as against the previous French record of 44,692 km. (27.9 miles) per hour. The longest straight-line distance covered with the autogiro was 16.4 km. (10.2 miles), again a multiple of the previous world's record, by Italy, of 1.786 km. (1.11 miles). Finally it succeeded in carrying through an overland flight of some length by going 80.604 km. (50 miles) and returning to the starting point, against the previous record, by France, of 44 km. (27.5 miles).

This autogiro is both lifted and propelled forward by two horizontally revolving three-bladed lifting rotors. The rotors are revolved by way of a gear train from the engine, which at the same time drives a cooling fan. The machine has no rigid supporting planes. In the event of failure of the engine, the machine can land without danger by volplaning.

With this most-recent great achievement of the German air plane-building industry, this report shall be closed. It will have shown that in Germany, all problems relating to aeronautics have been taken hold of with great energy, and that success has not failed of materializing. German science and engineering are indefatigably at work creating the groundwork on which new design principles, new machines, and therewith new possibilities in flying are based.

* * *

The Junkers "Ju 90" Forty-Passenger Air Liner

With the new Model Junkers "Ju 90" air liner, German air traffic has been given a transport means answering every modern demand as to speed, range, and size, and offering, moreover, the best in point of safety. This is so because this plane has been developed from the late and successful aircraft designs of the Junkers Flugzeug- and Motorenwerke. The new plane is not the first type with four engines which has been built by the Company, inasmuch as the "G 38," which was brought out in 1930, had this number of engines. The best known of the planes of this series is probably the "Generalfeldmarschall von Hindenburg," which at this writing has a record of some 3,500 flying hours in the service of the Deutsche Lufthansa A. G. During this extensive term of operation, the plane has not had to make a single forced landing, a proof of the high dependability of this four-engined craft. The number of passengers which can be accommodated in this plane is thirty.

The new "Ju 90" provides space for forty passengers, while at the same time the comfort of the individual passenger has been materially increased. It may well be said that, at present, no counterpart to this plane can be found anywhere in the world. The overall dimensions exceed those of a modern express-train car. The total length of the cabin is 10.5 m. (34.5-ft.) and its width 3 m. (9.8-ft.). The central passage-way is 0.5 m. (1.65-ft.) wide, so that it is possible to provide 1.25 m. (4.1-ft.) wide double seats on either side, Fig. 2. Accordingly, the seat surface per passenger is larger than in standard express-train cars. The comfort of the passengers is further enhanced by the reading lamps arranged above each seat, by the provision of facilities for accommodating small travelling accessories above or below the seat, by effective sound-damping permitting completely normal conversation during flight, and last though not least by good general ventilation of the cabin and the direct supply of fresh air to each individual seat.

Fig. 1—Junkers "Ju 90" four-motored forty-passenger air liner

Engines: Junkers "Jumo 211," starting output 1,100 h.p. each. The landing gear folds back into the engine nocelles during flight.
Span: 35 m. (115-ft.).
Wing area: 184 sq.m. (2,000 sq.ft.).
Weight, loaded: 21 tons.
Maximum speed: 410 km. (250 miles) per hour.
Cruising speed: 325 km. (200 miles) per hour.
Landing speed: 100 km. (60 miles) per hour.
Cruising range: 3,000 km. (1,900 miles).

Just like the time-tried three-motored Junkers Model "Ju 52," which is used by twenty-two out of forty of the world's aerial traffic Companies who are customers of the Junkers firm, the new "Ju 90" is also intended to go out and contribute its share to the

Fig. 2 --View showing appointments of cabin when plane is arranged for accommodation of 40 passengers. Eight facing upholstered seats form a compartment

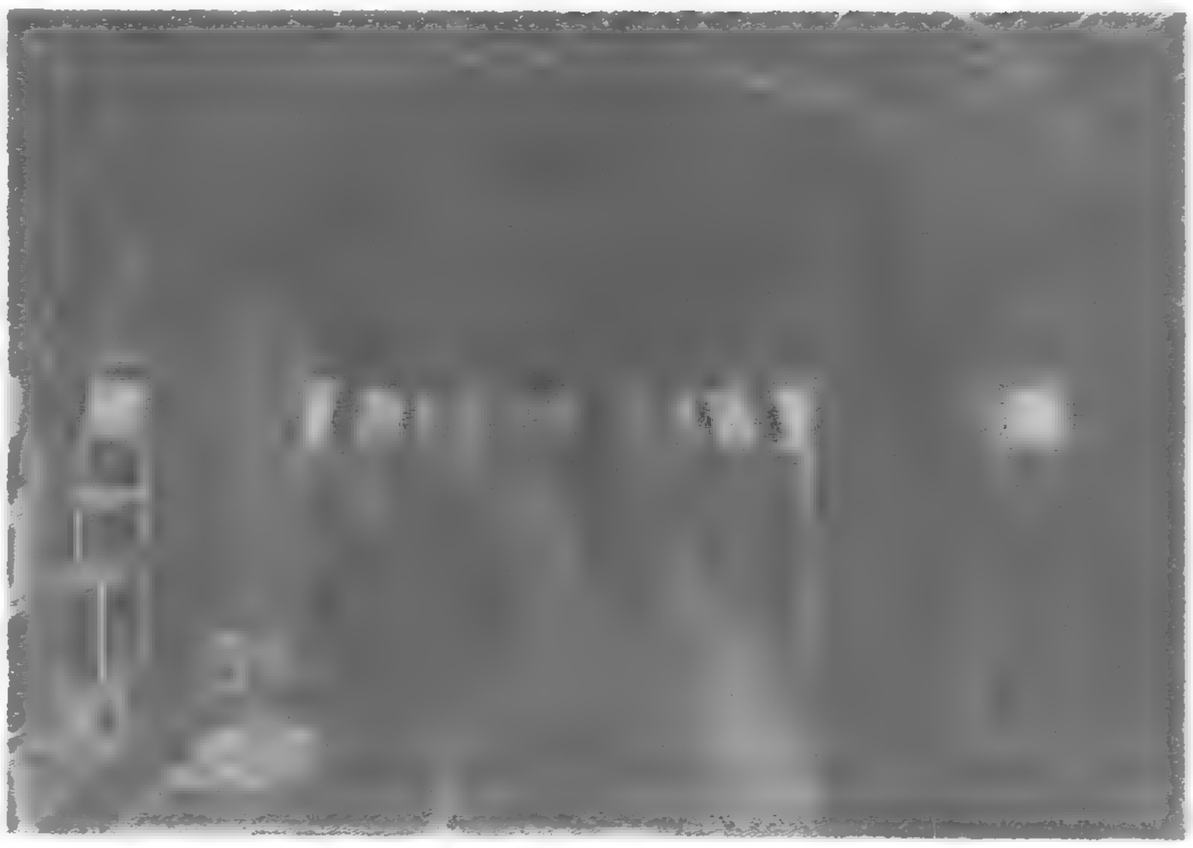


Fig. 3—View through the cabin space

further spread of the idea of air travel. Provision has therefore been made for dividing, appointing, and equipping the large cabin space, Fig. 3, in a variety of ways, as may be called for by prevailing conditions. The most important of these may be considered to be the following :—

(1) Five single compartments, each of eight seats facing each other. Smoking and non-smoking compartments may be provided.

(2) Individual compartments with built-in easy chairs designed to be converted into beds for night flying and for long flights.

(3) All seats facing in the flying direction. each chair arranged to be separately adjusted during flight.

(4) The accommodation of less than forty seats in the cabin, so that the comfort of passengers can be cared for still more extensively.

(5) The entire cabin fitted for use of the plane as an air yacht.

(6) The plane equipped for cargo service, or else for mixed passenger and cargo transport.

By assuming the first-named arrangement of the cabin, the following total space distribution is arrived at :—

Ahead of the passenger room proper is a cloak room at the right and a large space for passengers' hand luggage at the left. In front of these rooms at the left is the galley and the stewardess's cabin.

For the captain, board mechanic, and wireless operator, a common room without partitions is divided off. This is the first time that this arrangement has been employed. In front are two pilots' seats with dual controls side by side. Behind this is a large working-place for the wireless operator with his instruments, and the map table. It goes without saying that the instruments for safeguarding the flight include the necessary equipment for blind flying and blind and night landing. In addition to this equipment, the plane is provided with a course steering instrument by the Siemens Apparate und Maschinen G.m.b.H., of Berlin.

Behind the passengers' cabin is a vestibule. For purposes of rapid and frictionless handling at intermediate landing points, this vestibule is fitted with two doors, one for entry and the other for egress. In addition there are two roomy toilet and lavatory compartments, two further rooms for luggage, freight, or air mail, and an additional cloak room. Heavy luggage is carried in spaces of a total content of 10 cu.m. (350 cu. ft.), disposed below the cabin in the central portion of the wing. Altogether, the usable space of the plane enbraces 82 cu. m. (2,900 cu. ft.), which is amply sufficient to afford comfortable travel to forty persons. When used as a pure cargo plane, a total space of 87 cu. m. (3,100 cu. ft.) becomes available.

The "Ju 90" is an all-metal low-wing design. This type continues the Junkers tradition of offering passengers the highest degree of safety in all circumstances. In the design of the plane, special care was bestowed upon good accessibility to and interchangeability of vital parts. Air transport companies particularly value these features in Junkers planes as necessary to dependability and conducive to operating economy.

The wing is divided into five parts : the central portion, on which is seated the body, two intermediate portions with the inside engines, and two tip portions with the outside engines. The whole wing, including the part under the fuselage is of the Junkers double-section type. which ensures extremely good starting and landing qualities. At the outer wing sections, the double wing simultaneously serves in the capacity of ailerons. The landing speed of this 21-ton plane is under 100 km. (60 miles) per hour.

The landing gear is divided. It is attached to the inside engine nacelles and is folded back into them during flight.

Various types of engines, ranging from 800 to 1,200 h.p., may be built in. The engines may either be water or air-cooled. Although, in view of its use in traffic service, the plane is less designed for speed than for the transportation of large loads, it nevertheless reaches a notable maximum speed, of 410 km. (250 miles) per hour, when equipped with Junkers "Jumo 211" engines, which have a starting output of 1,100 h.p. In the event of failure of an engine, flight at an altitude of 4,000 m. (13,000-ft.) may be continued without loss in performance and steering properties. With a loaded weight of from 21 to 23 tons, the range of the new plane is about 2,000 km. (1,200 miles), a figure which completely suffices for intercontinental schedule service. The range may, however, be easily increased to 3,000 km. (1,900 miles).

Fig. 15—"Gotha Go 145" two-seater training plane with model As 10c "Argus engine.—*Gothaer Waggonfabrik A.G.*

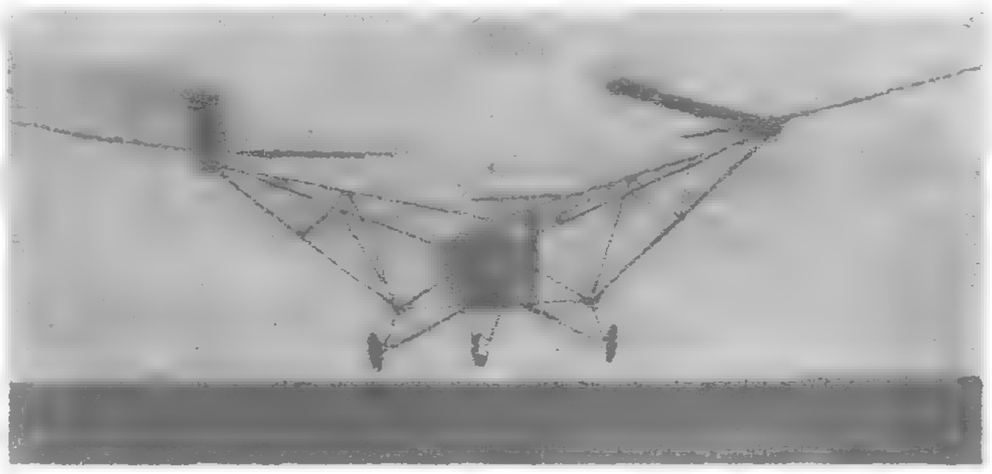


Fig. 16—"Fw 61" Autogiro with radial engine by the Brandenburgische Motoren-Werke, Berlin-Spandau

Air Transport Progress

THE history of air travel moves swiftly, as does actual traffic along the flying routes. Milestones of progress follow each other rapidly. To-day's wonder, in fact, becomes commonplace to-morrow. Just now the flying world sees the attainment of several fresh landmarks. One of them is the completion of eighteen years of mail transport on commercial flying routes as between London and the Continent. Another is the fact that the mileage of the world's air-lines has just attained, and slightly exceeded, a figure of 300,000.

There are those who recall how they stood out on the Hounslow aerodrome, on a misty morning in November, 1919, watching the departure for Paris of an aeroplane carrying the first mail-bag entrusted officially by the Post Office to the continental air routes. And progress since those days is illustrated by the fact that, whereas it cost half-a-crown in 1919 to send a letter for 250 miles between London and Paris, in 1937 one can send a half-ounce letter for 8,000 miles by air, from England to South Africa, at a cost of only 1½d.

Eighteen years is a brief period in the development of any new method of transport. Yet, so far as British air travel is concerned, it has seen a first London-Paris route develop stage by stage until, at the present time, the aircraft of Imperial Airways, and of its subsidiary and associated companies, are flying over just on 30,000 miles of European and Empire lines.

All the romance of air travel is borne vividly upon one's mind when one remembers that it is just eighteen years, now, since a "Vimy" biplane left Hounslow on a winter's morning on what was, in those days, the heroic adventure of a "blazing-the-trail" flight between England and Australia. To-day, however, great mail-planes fly along this route as a matter of routine, signalling their progress stage by stage, and adhering punctually to their time-schedules. But, when Ross and Keith Smith adventured across the Empire in 1919, landing-grounds were few and far between. Those first Australia flyers had no wireless by which to communicate with ground-stations. Neither had they any organization for effecting overhauls or repairs. They struggled, in fact, against difficulties innumerable ; but in the end they won through, opening-up the Australia route for many another feat of aerial skill and enterprise, and paving the way for the introduction, in due course, of regular commercial flying ; and now to-day we have active work in hand for operating the great new Empire flying-boats right through from England to Australia, and also for establishing a ground equipment to permit regular commercial night-flying—the goal aimed at being to operate a day-and-night service which, as schedules are speeded-up, gradually, will bring Australia within a week of England.

Eighteen years have also seen a pageant of progress on the North Atlantic. From heroic pioneer flights of 1919, fraught with the gravest peril, we have moved to the commercial survey flights of 1937, carried out to schedule over this all-important ocean route, and acting as a preliminary to the establishment, in due course, of a regular air-mail connecting our existing Empire air-lines with the airways of Canada and the United States.

Air Traffic Association's Work

Valuable work, in the general interests of air travel progress, continues to be done by the International Air Traffic Association, the membership of which comprises just on 30 airway organizations throughout Europe. Just at the present time, the experts of the Association are working on an important plan for introducing an improved form of code to simplify the exchange of traffic and other messages between the various European airways.

The need for a code is illustrated by the large and increasing volume of telegraphic and other routine communications which are passing from one air-line to another concerning reservations of passenger accommodation, and also in connection with the handling of baggage and freight.

Further interesting points emerge from a study of passenger traffic on British internal air-lines.

"During winter months," explains an official of Railway Air Services, "we find that more and more business men from the Midlands and the North are making use of the air when travelling to and from the Continent. What happens as a rule is this. Some situation arises in which the time-factor is particularly urgent, and a business man who has perhaps never flown before will decide to make a rush journey across to the Continent by air. In doing so, he finds not only that he saves an immense amount of valuable time, but that modern air transport is so comfortable that he reaches his destination fresh and unfatigued, and ready to plunge immediately into the urgent questions that may be at issue. Such a first experience of air travel proves, in fact, so satisfactory, from the viewpoints both of time saved and comfort ensured, that the traveller in question becomes a regular air passenger, flying up to Croydon by our morning services, and then catching a continental air-liner that puts him down a few hours later at destinations far across the Continent."

Co-operation of Shipping with Aircraft

One of the many facts which emerge from recent North Atlantic commercial survey flights is the valuable nature of the assistance which was rendered to the long-range flying-boats of Imperial Airways by ships on the ocean routes.

On each occasion, before the "Cambria" and the "Caledonia" began their respective crossings, the position was ascertained of all surface vessels likely to be useful to the flying-boats for wireless contact purposes. Then, prior to each flight, two preliminary notices—one 24-hours before the time scheduled for starting, and another six hours before the aircraft ascended—were broadcasted to shipping, thus enabling wireless operators in surface craft to be on the look-out for signals from the flying-boats. Ships contacted by the flying-boats reported their positions. Wireless bearings were also taken on them by the flying-boat operators. More than once, after a ship and a flying-boat had been in wireless communication with each other, those in the flying-boat actually sighted the vessel in question on the Atlantic below, and visual as well as wireless signals were exchanged.

Impending air developments which have just been reported indicate the growing importance of commercial aircraft in connection with various aspects of agriculture.

In the United States a scheme is now being completed for making a series of survey flights during which photographs are to be taken by experts in connection with official investigations as to crop distribution.

In Canada, timber surveys by air are to be extended, while other uses for aircraft, in connection with agriculture, are in sowing seeds from specially-equipped machines, and in dropping chemicals from the air for the destruction of insect pests attacking crops.

Air-base at Singapore

Further details are to hand concerning the commercial marine air-base which has been provided at Singapore for the handling of flying-boats of the Empire type.

The special seaplane slipway which has been constructed is 100 feet wide, its total length being just over 600 feet. Four lines of rails, laid flush along the concrete decking, are provided for hauling up flying-boats which need to be taken from the water for overhaul or repair ; while at the head of the slipway is a level paved area for the handling of flying-boats and seaplanes, this area being connected by a taxying strip to the main hangars. Full modern facilities are also provided for the embarkation and landing of passengers, mails, and freight.

Night-flying in Australia

It is with a view to increasing the speed of airmail services between the principal cities of Australia, that the Civil Aviation Board is now developing a comprehensive lighting scheme which will enable night-flying to be conducted on a routine basis.

According to the latest information, this plan includes not only the illumination of existing main aerodromes, but also the preparation and lighting of a chain of intermediate landing-grounds; while light beacons are to be placed along the main routes.

The Imperial Airways flying-boat, the "Satyrus," has completed her survey flight along the new marine air route eastward from

(Continued on page 62)

New Hydro-Electric Power Station in Japan

By Y. TAJI, in The Engineer

THE Imperial Japanese Government Railways intend to electrify all railways radiating from Tokyo, and a few years ago a large power station equipped with turbo-generators and water tube boilers was built at Tsurumi, near Tokyo and Yokohama, to supply current for the main and local lines as well as for the inner and outer circular lines in the vicinity of the capital in conjunction with hydro-electric power stations.

A new hydro-electric power station—the Sente—is now under construction in Niigata Prefecture, in the north of the main island of Japan, where five sets of 60,000 h.p. water turbines and 31,000-kw. alternators are to be installed. It is expected that the station will be ready for service in 1938.

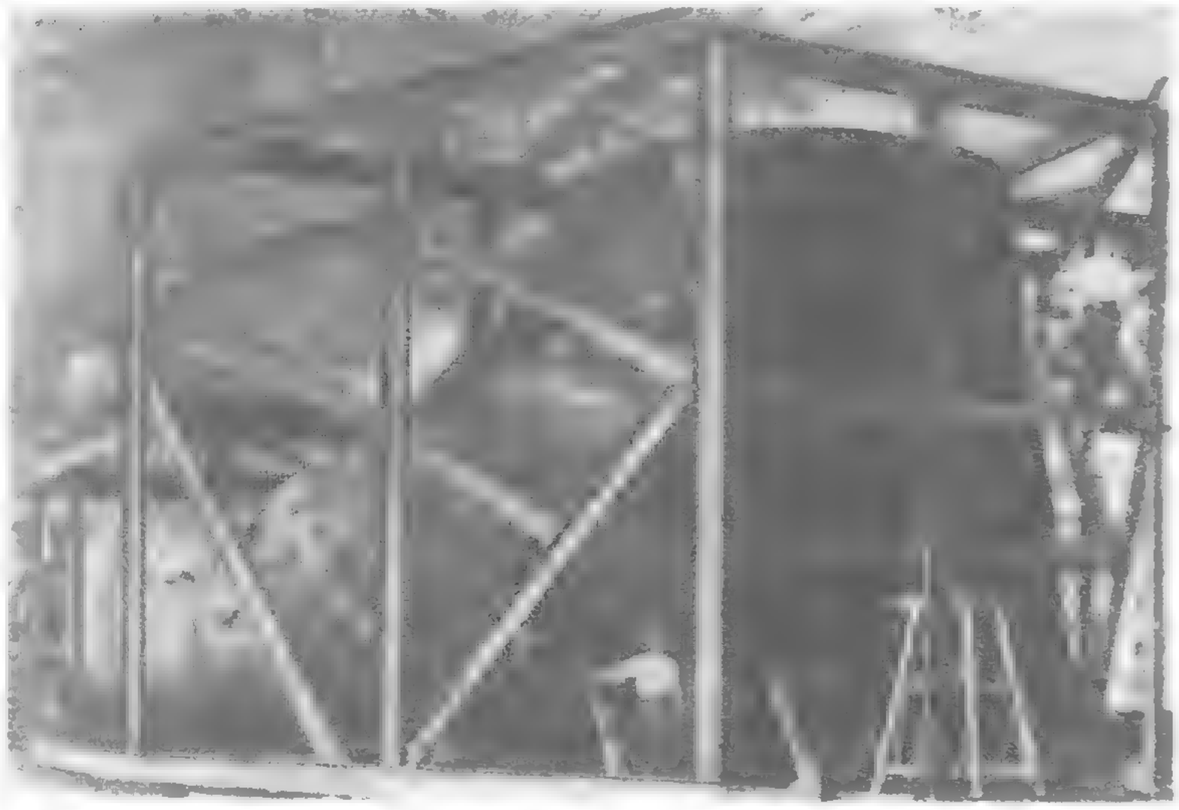
Three of the units have recently been completed at the Sukegawa Works of the Hitachi Engineering Works, Ltd., which possess complete facilities for manufacturing hydraulic and electric machinery of every description, including steel forgings, castings, electric cables and wires, insulating materials, valves, cocks, and all other necessary accessories, so that the entire construction of these turbines and generators has entirely been entrusted with these works.

The Shinano, the largest river in Japan, is utilized for the generation of power. The flow of this river varies considerably in the course of a year, and it was necessary to provide for a range between 44 m. and 58 m. in the head of water. The turbines are of the vertical shaft Francis type, each with a maximum output of 44,700 kw.. or 60,000 b.h.p., at a maximum head of 58 m. The normal output is 31,000 kw. at an effective head of 56.2 m. with a normal water consumption of 62.5 cubic meters per second. The maximum efficiency of the turbines is 92 per cent when the effective head and water quantity are 50 m. and 62.5 cubic meters per second, respectively. The normal speed of each turbine is 150 r.p.m. If the load of the main generator is cut off the speed rises to 120 per cent of the normal revolutions per minute, when the effective head and the volume of water used in each turbine are 44 m. and 77.5 cubic meters per second, respectively.

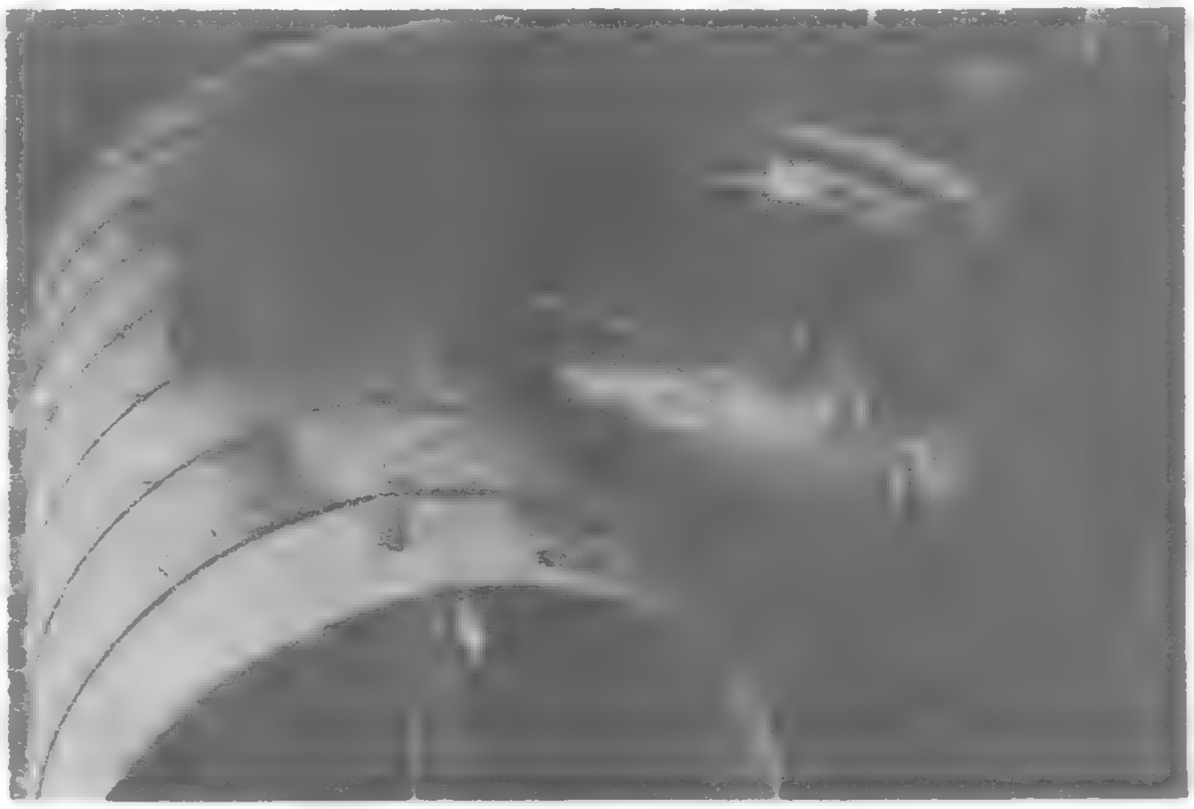
The runner is of cast steel and has a maximum diameter of 3.736 m., a height of 1.55 m., and a weight of about 23 tons. Stainless steel is used for the liner. The runner has been tested up to 197 r.p.m. Since the loading gauge of railways in Japan is only 3.1 m., the Ministry of Railways built a special carriage for the transportation of these runners, and it was found that the diameter of 3.763 m. is the maximum limit which could be transported by rail. Hence, unless the method of transportation is altered in the future there will be no possibility of building a larger runner for a Japanese power station

The casing is of steel plates, 32 mm. in thickness, riveted together in the works. The inlet diameter of the casing is 4.5 m., the diameter of the spiral 5.6 m., and the maximum outside dia-

THE SENTE HYDRO-ELECTRIC POWER STATION



60,000 h.p. water turbine draught tube



60,000 h.p. water turbine casing

31,000 kw. alternator rotor

31,000 kw. alternator on the test bed

meter 12 m. The total weight is about 90 tons. The main shaft is of mild steel and has a diameter of 750 mm., a length of 3800 mm., and a weight of 17 tons. It has a liner of stainless steel. The main inlet valve is of the vertical butterfly type, operated by oil pressure, and is 4.5 m. in diameter.

For each water turbine an 85 h.p. horizontal Francis type water turbine is directly coupled to a pressure oil pump and a lubricating oil pump. An electric motor of the same horse-power is also directly coupled to the same pumps. This motor is generally employed to drive the pumps, whilst the water turbine is for emergency use. The draught tube is constructed of steel plates 12 mm. thick embedded in concrete.

60,000 b.h.p. turbine runner

Alternators

The A.C. generators are of the vertical axis, revolving field, closed ventilating type with air coolers, and the normal output of each generator is 31,000 kva at 150 r.p.m. The voltage and periodicity are 11,000 and 50, respectively, whilst the power factor is 0.97. Each generator has a main exciter of 210 kw. at 220-volts of the high-speed type and an auxiliary exciter. The total weight of the generator is 550 tons.

In order to minimize the speed variation for a large load variation a rotor with an enormous inertia effect, 6600 meter-tons, is provided. The outside diameter of the rotor is about 7 m. and the height is 12.5 m., whilst the weight is 300 tons. The rotor yoke is made of laminated sheet iron plates punched accurately into the shape of sectors. After having been tested at the works they were dismantled and then reassembled at the power station. This plan was adopted in view of the difficulties of transportation by railways. The rotor spider is of cast steel.

Cooling of the generator is effected by a circulating ventilating system with an air cooler so as to prevent the entry of dust and insects, even after long years' running, and also to ensure compactness and pleasing appearance.

The short-circuit ratio is about 1.7. With this large ratio and the large inertia effect of the rotor the size of the generator is very great and it would equal a 50,000 kw. generator of ordinary design. Several views of the plant are reproduced herewith.

Special Features of Design

Special features of the design of the complete installation may be summarized as follows :—

(*a*) To meet a large variation of the effective head.

(*b*) To meet a large variation of the load.

(*c*) Special precaution has been taken in the design of the machinery for parallel running with a heat-engined power station.

(*d*) Owing to the unfavorable quality of the water, special steels are used against wear, corrosion, and erosion of the parts which are in direct contact with the water.

(*e*) As the parts of the machinery are extraordinarily heavy and the water quality is bad, special arrangement is made for overhauling the turbines independently of the alternators.

(*f*) Model experiments were carried out with three kinds of runners and draught tubes, and the best was adopted.

(*g*) In order to minimize the rate of speed variation against the large variation of load the rotor of the generator is designed for a very high inertia effect.

Air Transport Progress

(Continued from page 60)

Alexandria to Singapore, and she will in due course return over the same route to the air-base at Alexandria.

Celebrating the Stamp Exhibition held recently in London, souvenir stamps have been issued in which the central feature, printed in blue, is a picture of one of the big new Imperial Airways flying-boats of the " C " class.

Change in Schedule

Imperial Airways has announced that following on the successful completion of survey flights between Bangkok and Hongkong, it was decided to connect Hongkong with the main trunk route between London and Australia at Bangkok, instead of at Penang as hitherto.

The change of route, went into effect on Sunday, December 5, on which day " Dorado " left Hongkong for Bangkok and " Delphinus " left Bangkok for Hongkong. The route followed :

Hongkong—Fort Bayard—Hanoi—Udorn—Bangkok.

No traffic may be accepted for carriage to or from Fort Bayard, Hanoi or Udorn, this regulation applying to passengers, mail and freight. The schedule of the new route is as follows :—

Westbound :	Dep.	Hongkong	11.00 L.S.T.	Sunday
	arr.	Hanoi	Afternoon	,,
	Dep.	Hanoi	09.30 L.S.T.	Monday
	arr.	Bangkok	Afternoon	,,
Eastbound :	Dep.	Bangkok	06.45 L.S.T.	Sunday
	arr.	Hanoi	Afternoon	,,
	Dep.	Hanoi	06.00 L.S.T.	Monday
	arr.	Hongkong	13.00 L.S.T.	,,

The new schedule incorporates an acceleration of one day on the present time-table London/Hongkong and vice versa, reducing the total transit time to eight days in either direction. It must be pointed out, however, that it has not been found possible to maintain equally advantageous connections to Malaya and Australia. The total transit time Brisbane/Hongkong and vice versa will be increased to nine days, whilst to Singapore it will be five days. This increase in the present transit time of five days to Brisbane, and two days to Singapore, is due entirely to unfavorable connections at Bangkok but it may be pointed out that certain alterations are in view, namely :

(i) The new route Hongkong/Bangkok is approximately 300 miles shorter than the present route Hongkong/Penang. It is hoped eventually to fly Hongkong to Bangkok and vice versa in one day, and the present very elastic schedule is being instituted in order that experience may be gained of the route with that end in view.

(ii) The land-planes in use between England and Australia are gradually being replaced by the Empire Flying-boats prior to the application of the " All Mail by Air " Scheme to the Australian route.

These flying boats are already in regular operation between London and Karachi, a preliminary flying-boat survey of the section Karachi/Singapore was completed by " Satyrus " in October, and " Cordelia," one of the Empire Flying-boats, completed a second survey to Singapore on November 21.

It will be appreciated, therefore, that regular operation of the Empire Flying-boat from London as far as Singapore may be anticipated in the near future, the greatly increased speed of these aircraft producing further accelerations in schedule and consequential alterations in time-table.

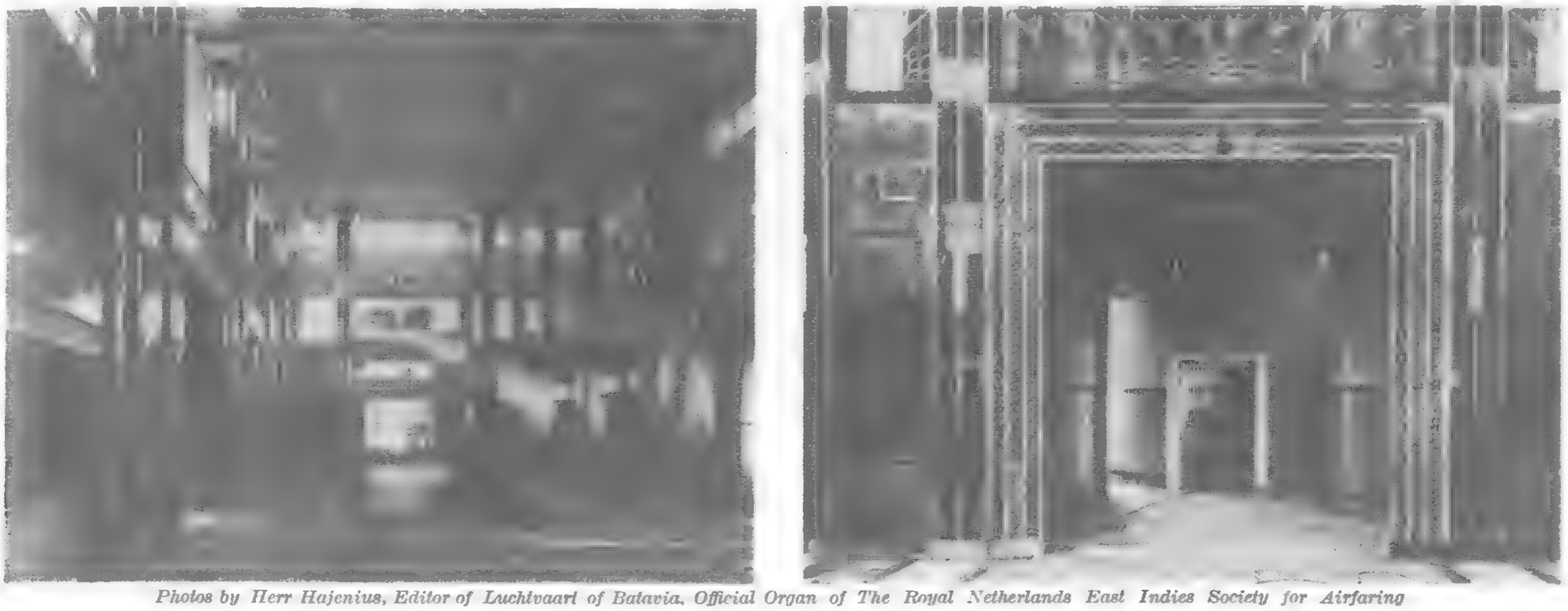
The present time-table must therefore be regarded as a temporary measure, and it is hoped that the connections at Bangkok will be adjusted in the near future to provide a faster schedule to Australia. Offsetting the present serious disadvantages of increased transit times between Malaya and Australia are the following :

A saving of one day to all points between Bangkok and London.

A saving of 300 miles in the mileage between Hongkong and the trunk line, holding forth the possibility of yet a further reduction of one day in transit times.

An appreciable increase in the amount of paying load which may be carried on each aircraft, owing to landing grounds used being closer together than on the present route.

In view of the rapidly increasing air mail loads being carried to and from Hongkong, this last point is one of considerable importance to all concerned.



Photos by Herr Hajenius, Editor of Luchtvaart of Batavia, Official Organ of The Royal Netherlands East Indies Society for Airfaring

Interior views of Singapore's newly completed Airport, at left, the Main Hall ; right, the Side Door leading to the Main Hall

More About the Singapore Airport

Singapore's Airport, says a writer in The Aeroplane, is not only the finest airport in the British Empire, it is probably the finest in the World. Even when Berlin's great new airport at Tempelhof is finished, with all the advantages of Doctor Sagebiel's genius as an architect, it will still lack Singapore's advantage in being a seaplane port as well as an aerodrome for landplanes.—Apart from all that Singapore is strategically one of the most important airports in the World. It is the main junction of the lines to Australasia and to Borneo and to the Filipine Islands and to the Far East. The following article, which is reprinted from The Aeroplane, was written by a resident of Singapore who has watched the growth of the airport from the filling in of the swamp to the last link in the radio aerial.

* * *

THE proposal to build an aerodrome for civil use on Singapore Island came late, in fact it was not until 1928 that any serious move was made towards the selection of a site.

This delay was doubtless influenced by three considerations. The first was that at that time no commercial companies were operating either external or internal air services ; secondly, that when they began to do so permission would probably be forthcoming for the temporary use of the Royal Air Force Base, then under construction by the Air Ministry at Seletar (adjoining the site of the Singapore Naval Base) ; and finally that the Government was averse to making any hasty and perhaps irrevocable decision in regard to the all-important question of a suitable site.

As matters have turned out—for example, Imperial Airways' policy of supplanting land machines by flying-boats—that cautious attitude has been well repaid.

When once the decision to provide an airport for Singapore had been taken, several alternative sites on the Island were marked out and their possibilities carefully examined. They all suffered from one common defect, namely the distance separating them from the metropolis they were to serve.

At this stage in the proceedings Sir Cecil Clementi was appointed Governor, and in due course he made several flights over the Island to see exactly how matters stood. Finally, he decided to abandon all the sites that had been examined and came down in favor of a site in an evil-smelling tidal swamp.

Having done that, he proceeded to press its advantages—and they were fairly obvious—to such purpose that the site was finally approved by the Secretary of State in consultation with the British Air Ministry.

The Governor had the following facts to go on :—

He had been assured by the Director of the Public Works Service that the conversion of the swamp into an airport was possible, given money and time for such an undertaking.

Secondly, Government had had under consideration for some thirty years or so a scheme for the reclamation of this swamp as a health measure.

Thirdly, it was the nearest of all the sites to the City (less than two miles from the G.P.O.) and it offered facilities for both land and seaplanes.

The Main Hangars and Offices at the Singapore Airport

Gang Rollers, Gang Mowers and a Chain Harrow on the Aerodrome at Singapore

Some idea of the difficulties to be faced in turning the swamp into an airport may be gathered from the following facts :—

(i) The site covered in all some 350 acres,

(ii) Below the floor of the Basin there was nothing but mud to a depth of over 100-ft.—not exactly ideal conditions on which to build hangars, slipway and wharf.

(iii) At high water there was enough depth to float ocean-going vessels—there is a photograph which shows two vessels of 3,000 and 2,000 tons respectively afloat on what is now the center of the landing ground.

Here are some of the main features of the airport. The aerodrome covers some 250 acres, of which the circular landing ground, 1,000 yards in diameter, occupies 160 acres. One half of the perimeter is washed by the sea, and the other half merges into the adjoining area wherein are located the Terminal Buildings, hangars, flying club and so forth.

The filling needed to reclaim the swamp was brought in from a hill some four miles distant.

The trains used for hauling the filling followed each other at eight minute intervals for ten hours a day non-stop for four years.

The total amount of filling so used was 7½ million cubic yards, and the cost nearly half a million sterling. The plant used for digging and hauling was all British.

To dump six million tons of filling onto mud took some doing, for mud is not a particularly stable medium on which to build. Nevertheless, rigid precautions and the placing of the filling-in layers were in the end successful.

The landing ground for drainage purposes is domed. The rise to the center is on an upward slope of 1-in-160. The ground is, of course, underdrained, and the total length of pipes so laid is about 40 miles. The surface is finished off with a layer of loam in which is planted a specially selected grass.

Before being opened to traffic the ground was tested to five tons per sq. foot, it has been in use in all weathers for some five months and there have been no complaints from the companies using it.—Rather the reverse.

You already know all about the Terminal Building, which contains offices for five companies, a restaurant with rather spectacular mural decorations on its glass walls. Accommodation on the roof will hold about 2,000 people on gala days.

The building operates on the one-way traffic principle : inward and outward traffic are kept separate, as also are mails and freight, so there is as a result an orderly coming and going which it is calculated can handle the maximum of traffic in the minimum of time without confusing and exasperating the public.

The Control Tower contains a W/T cabin, with direct reception and remote transmission. A separate cable communicates with the Marconi Adcock D/F station two miles away.

Of course, there is a switch-board for the control of the entire aerodrome illumination, which includes aviation orange boundary-lights spaced at intervals of 100 yards round the landing ground and on either side of the seaplane channel, obstruction lights on all buildings, an illuminated wind-T, six floodlights so placed as to cover any portion of the landing ground, and other floodlights for general illumination of the concrete apron.

On the roof of the tower is a Neon beacon for the guidance of aircraft approaching at night. It incorporates a device whereby at the will of the Control Officer it can be made to flash in Morse code the letter " S " for Singapore.

The hangars, of which there are two, each measures 300-ft. in length by 150-ft. in width, with a doorway height of 35-ft.

Running the full length and forming one side of each hangar is a built-on two-floor brick annexe, which contains workshop and stores accommodation on the ground floor with offices above for the use of air transport companies.

Each hangar opens at the side and end. The doors, which are manually operated, are 150-ft. wide.

Surrounding the hangars and the terminal building is a paved concrete apron, covering in all some 15 acres. It provides ample room for the manœuvring of aircraft, and the handling of mails and freight, all of which is thus done on a clean hard surface.

Immediately in front of the Terminal Building the pavement is laid in green concrete, so as to mitigate the fierce tropical glare. This portion of the apron also carries extensible or telescopic canopies (copied with acknowledgments from Gatwick) for connecting machines with the building during rainstorms.

The seaplane silpway and wharf are situated on the Western perimeter. The former, which has been designed for a load of 84 tons, is 100-ft. wide and is inclined at an angle of 1 in 15. Its total length is 262-ft.

The tail of the slipway remains submerged to a depth of 5-ft. during extreme low tide. Four lines of rails laid flush with the decking provide a choice of gauge for the hauling-up of any flying-boat or float plane which may need to be taken from the water for overhaul or repair.

At the head of the slipway a paved concrete area for the handling of machines connects by a taxi strip with the hangars.

The wharf, which is beside the slipway, provides a convenient means for transhipping passengers, mails, freight, etc., to flying-boats lying at anchor in the adjoining mooring areas.

A two-ton electric crane is available on the wharf for the handling of aircraft engines and heavy stores.

The waterway, from the mooring area to the outer harbor, consists of a dredged channel 600-ft. wide and about a mile long. This channel is flanked on either side by a continuous floating timber boom designed to exclude floating debris and other obstructions. At night it is defined by electric lights spaced at 300-ft. intervals, terminating at the seaward end in two flashing " port " and " starboard " beacons.

Other features of the airport include a fully equipped meteorological station, premises for the Royal Singapore Flying Club, fuel depots for oil companies, car parks, garages for staff and visitors' cars and so forth.

Boring Usami Railway Tunnel Completed

Boring of the Usami railway tunnel to link Ito on the eastern coast of Izu peninsula in Shizuoka Prefecture with northern shore points was completed early in January.

Drilling started in January, 1933, and required 350,000 man-days of labor. The cost was estimated at Y.3,000,000.

Among the difficulties encountered in pushing through the tunnel were the high underground temperatures due to subterranean hot springs. Even now the temperature stands around 78° F. inside the excavation but operation of trains will not be hindered. At one time, however, Government engineers seriously considered abandoning the project on account of the so-called " thermo-soil " encountered.

Actual laying of rails in the tunnel should be completed by November this year engineers say. After November a through train from Tokyo to Ito will be placed in operation.

Tunnel Driving in the Philippines

By a Correspondent in The Mining Journal

ONE of the most difficult problems encountered by mining operators the world over, is that of handling excess water as the workings go to deeper and deeper levels. This problem is more acute in the Philippine Islands than in most countries because heavy rainfall and badly broken formations tend to make the mines unusually wet. In the mountainous parts of the Islands extremely steep, rugged hills make it possible to cut the structures in many places some distances below their outcrop by more or less short tunnels. Even in such operations, however, drain tunnels of some kind or other are almost always essential.

The Palidan Suyoc Deep Level Tunnel Co. was organized in July, 1936, for the purpose of driving a crosscut adit to prospect a large area of the almost unexplored territory, covered by the claims of three distinct mining companies, and to tap the vein system of the Suyoc Consolidated Mining Co. more than 800-ft. below the collar of the shaft. Thus the double purpose of providing drainage for Suyoc Consolidated and permitting the development of a large area, believed to contain ore deposits of considerable value which could not previously be opened because of excessive flow of water, will be served.

The company has an authorized capital of P.800,000, which was readily raised. It is under the management of Marsman Co., managers of Suyoc Consolidated, and has a contract with Suyoc whereby a small percentage of the total profits of that company go to Palidan Suyoc as soon as the tunnel cuts the Suyoc workings. In addition, the tunnel company will share in the profits of working whatever ore is discovered in the area under the claims staked by independent companies.

Preliminary work on the tunnel project was done by R. W. Crosby, manager of the northern division of Marsman & Co.; J. O. Enberg, of the board of Consulting Engineers of that firm; and by L. M. Robinson, general superintendent of Suyoc Consolidated. Lloyd Pratt, who was on the staff of the Itogon Mining Co. in the Baguio district at the time the tunnel was under discussion, was chosen as tunnel superintendent. Mr. Pratt had had extensive tunnel experience at the Cascade Tunnel, in Washington; Los Angeles Aqueduct, Hoover Dam Diversion Tunnels, and many other tunnel projects in the Western United States.

It was decided that good footage could be made economically by the use of a drill carriage, mechanical loader, and other modern equipment, although the general tendency in the Philippines favors the use of as much hand labor as is possible.

Before the tunnel could be started, a road had to be built from Suyoc Consolidated to the portal, a distance of some four kilometers around mountainous country. This road was started in September, 1936, and completed late in December; it is 3.5 meters wide, and has never been closed, except for a short time, despite torrential tropical rains which are common in the district. A 4,000-volt power line was constructed over the hill from Suyoc Consolidated power house to the transformer station at the tunnel, as was a telephone line. A mess house for the American staff, bunkhouses for the native crew, cottages for native foremen, an office, a warehouse, compressor and shop building were all built in short order.

When completed the tunnel will be about 9,450-ft. long, with a cross section 11-ft. by 11-ft. inside the timbers. It is being driven on a grade of ½ per cent of 1 per cent and will cut the Suyoc Consolidated workings a little more than 800-ft. below the collar. The tunnel line almost exactly crosscuts the general strike of the Suyoc Vein system, and will, in one place, have backs of nearly 2,000-ft.

Considerable doubt existed at first as to the possibility of teaching modern mechanical methods to the available labor. In general mining men have found that one idea at a time is all that the typical Filipino laborer can assimilate. Through the organizing ability of Mr. Pratt, and the patient teachings of the shift bosses, Mr. Maurice Walser, Mr. Herman Stokes, and Mr. Arnold Long, untrained labor was quickly made into efficient crews. The rate of advance compares very favorably with that of records made in American and foreign tunnels. By inducing friendly rivalry through competition between shifts, a very keen spirit has been developed. A bulletin board erected near the office, showing the performance of each shift and the footage made each day, has helped in promoting this rivalry, as has the policy of keeping the crews separated as to tribes: one crew consists entirely of mountain Igorots, while the other two are lowlanders.

Drilling

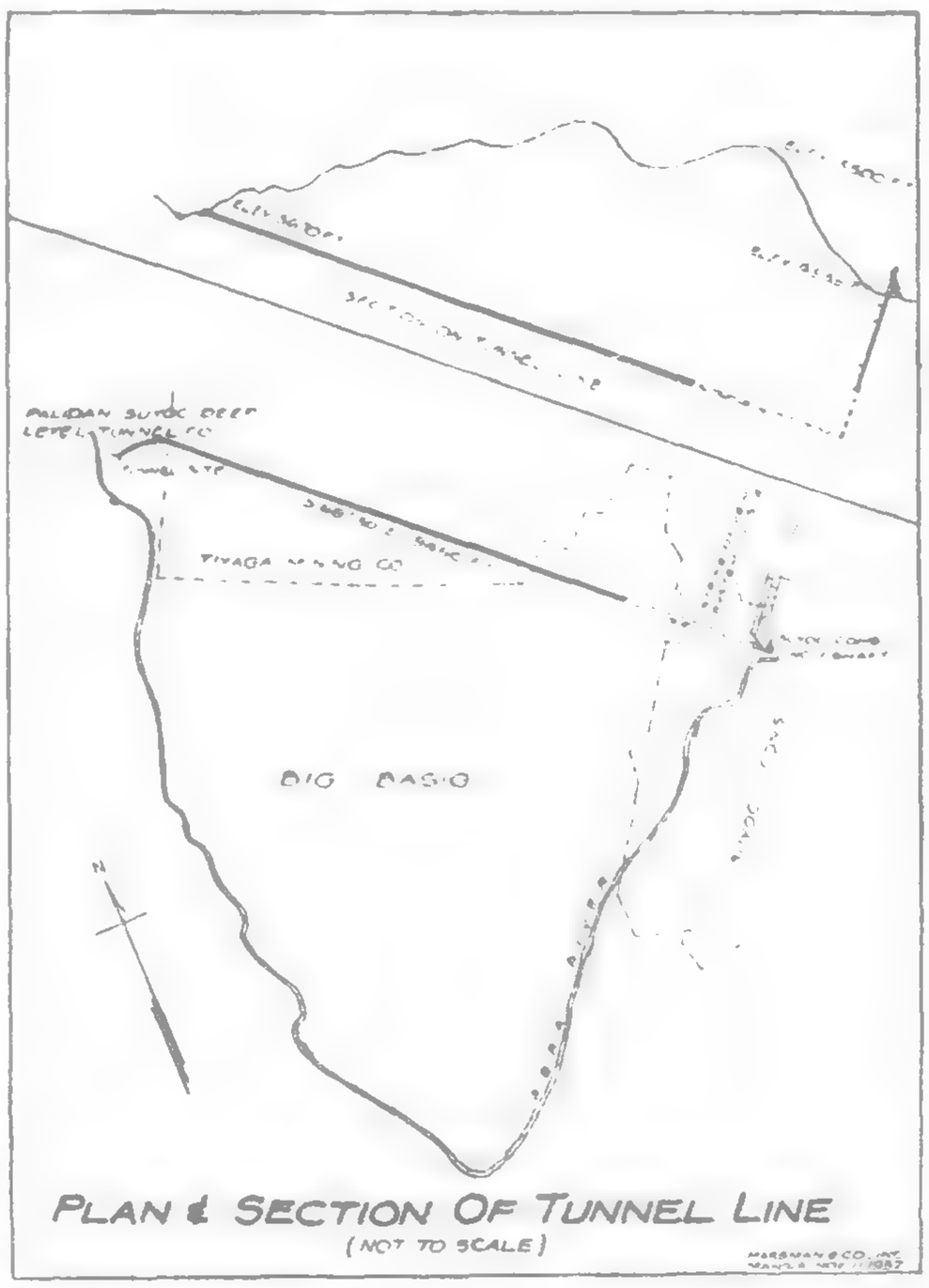
The drill carriage, or "Jumbo" used at Palidan was designed by Mr. Pratt, who attempted to remedy a number of mistakes which had been made in the design of earlier carriages in the States.

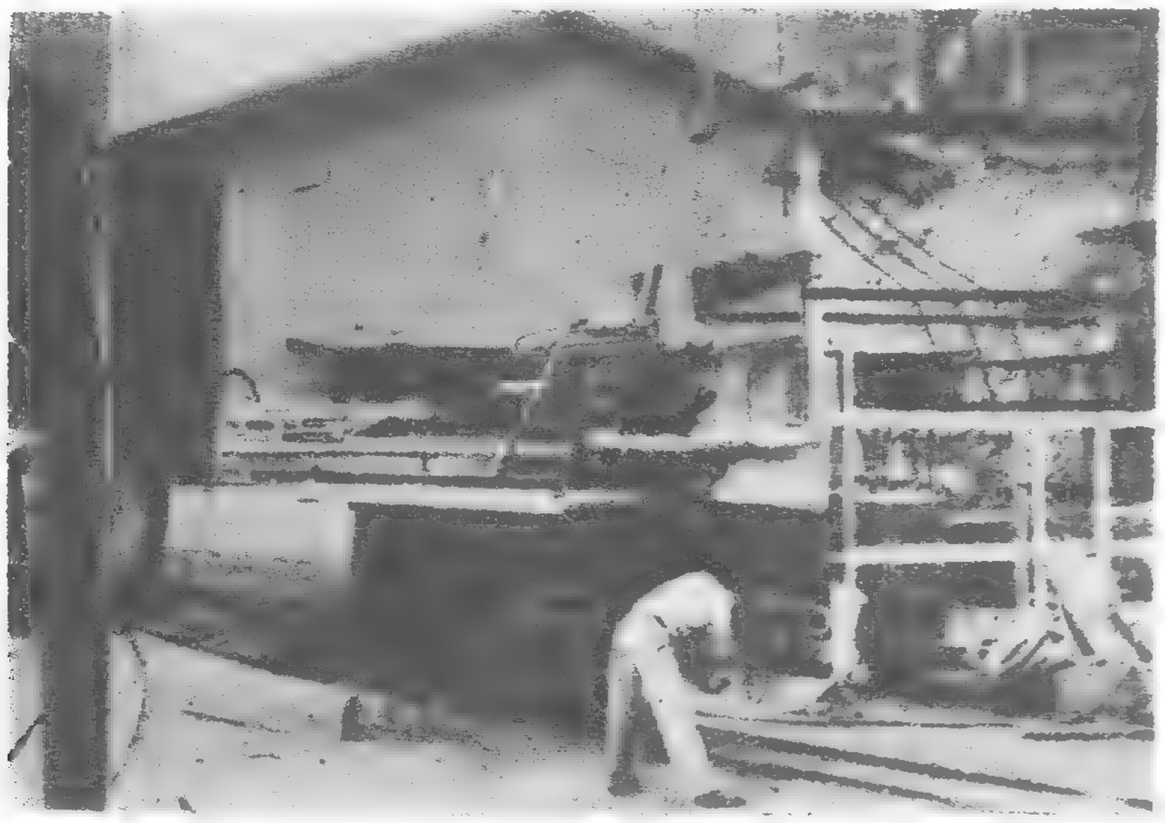
The Jumbo is made entirely of structural steel, chiefly of U-cross section and is held together by riveting and welding. Due to the small section of the tunnel, the carriage was made rather longer in proportion to its width than previous ones, in order to give sufficient weight. The frame is simply an oblong skeleton, mounted on a pair of 24-in. gauge trucks. Hinged near the top are the "wings" or platforms which are lowered when the Jumbo is moved to and from the face. Each wing is made in two sections, to facilitate lowering and raising. On top of, and parallel to the frame at the front are two extra heavy 4-in. pipes to which are welded the vertical columns.

To each of these columns is attached, by universal clamps, the arms on which the top machines are mounted. The "lifter" machines are likewise mounted on arms attached to columns which are rigidly fastened to the frame. Air is supplied through a 4-in. manifold which runs from the right hand rear of the frame, around the front, and back the other side to a blow-off valve. Line oilers are attached to all distributing lines. Water is supplied by a similar manifold.

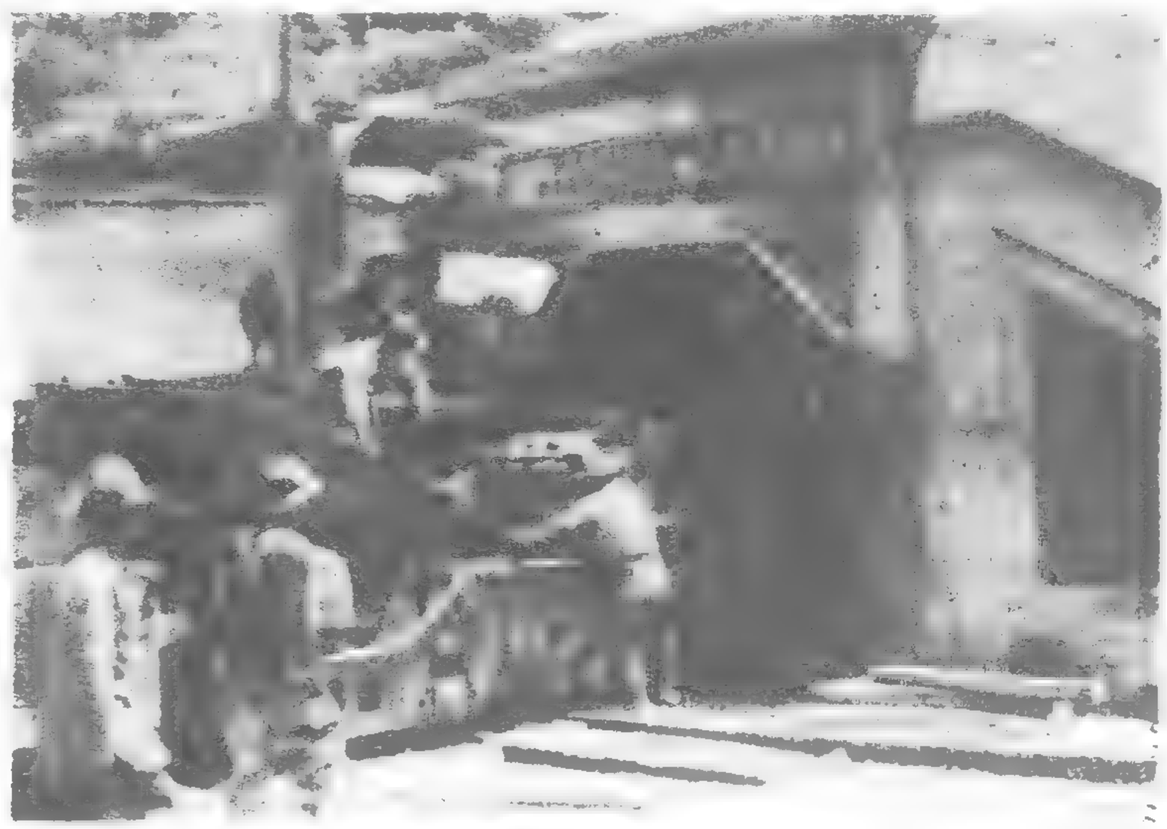
Four 3½-ins. Worthington pneumatic feed drifters are mounted on the "Jumbo." These Worthington drills were the first to appear in the Philippines. Consequently they caused much comment and many questions on their efficiency. The service given by these machines has been excellent. Shown below are the costs per foot for four months for machine drill repair, which it is believed are remarkable in view of the fact that these machines were handled by native laborers, who had never seen the machines before and knew nothing of their operation and care:—

	Machine and Repair Parts Costs	*Footage*	*Cost Per Foot*
May ..	P.152.33	540	P.0.28
June ..	203.90	1,088	0.19
July ..	697.36	1,327	0.53
August ..	444.65	1,175	0.38





The Jumbo



Conway loader entering the tunnel

In use, the Jumbo is pushed into the face by the locomotive and the air and water hose connected. The line is always blown down to drain any condensed water before drilling is started. As soon as the lines are connected and blown out the drills are started, they having been lined up while the hoses were being attached.

In the present ground about 30 holes are drilled. These are blown and loaded, from the Jumbo, with about 10 sticks of 40 per cent dynamite per hole of $1\frac{1}{8}$-in. by 8-in. Electric caps are used entirely, eight delays being used. A rather clever shooting switch has been devised which provides the maximum safety. This is an ordinary safety knife switch with a lock, to which only the native "capataz" has a key. The unusual part is a lead wire to the switch which must be stretched across the tunnel and plugged into a socket on the opposite rib before the round can be fired. For shot firing 440-volt alternating current is used.

Lugged drill steel, $1\frac{1}{4}$-in. round, is used. The steel shop is provided with two Ingersoll-Rand model 50 sharpeners, one Ingersoll-Rand "R 26" and one Gardner Denver "50" furnace. Dulled steel, as soon as removed from machines, is stacked on a flat car behind the "Jumbo." This car is hauled to the steel shop as soon as the round is drilled out and the dulled steel piled on the floor of the shop. The car is then immediately loaded with sharp steel from a rack just outside the shop. During the mucking cycle, the steel car is taken to the siding on which the Jumbo rests and the steel transferred to a rack on the top deck of the Jumbo.

Steel Gauges and Lengths are as Follows:

Table I Drill Steel

Starter	4-ft.	$2\frac{1}{8}$-in. gauge
First Change	6 ,,	2 ,, ,,
Second Change	8 ,,	$1\frac{7}{8}$,, ,,
Third Change	10 ..	$1\frac{3}{4}$,, ,,
Finish	12 ,,	$1\frac{5}{8}$,, ,,

Mucking

A type 50, short boom Conway loader was ordered for this tunnel, but due to shipping delays, it did not arrive at the tunnel site until May 20, 1937. Up to this time mucking was entirely by hand. The tunnel was started entirely by hand, driving a top heading by hand drilling and then breaking the bench. When the Jumbo was put into service in April the speed of driving was naturally greatly increased. By this hand mucking a rate of about 250-ft. per month was maintained.

While the speed of advance recently can be attributed in part to better ground and to the natives becoming more familiar with the routine, there is very little doubt that the greater part of the credit must go to the mucking machine. For example, in the period May 1 to 20 an advance of 161-ft. was made. In the ten remaining days of the month 379-ft. was made!

The improved California switch is used for shifting cars. This is about 150-ft. long and is moved forward each day during the drilling cycle, using the mucker as a locomotive for pulling it.

In practice a car is coupled to the mucker and filled in about 40 secs. The locomotive, with its train of cars, immediately hooks onto this car and pulls it onto the siding. As soon as the switch is cleared an empty car is hand trammed to the mucker and the cycle repeated. A five ton Goodman storage battery locomotive was put into service in August. As soon as a train is made up it is hauled to the tipple, the cars dumped and returned to the California switch. While the locomotive is taking out the train, cars are hand trammed both to and from the mucker.

Cars used are 45 c. ft., Granby Automatic Dump, with $\frac{3}{8}$-in sheet iron sideboards added. These cars are most satisfactory, particularly in dumping, but are too small.

As soon as the loader has cleaned up to the limit of the rail a six foot section is immediately laid. These sections are a new departure in tunnel driving and have been responsible for much saving in time. They differ from the usual section in that the six foot lengths of 40 pound rail are welded direct to $\frac{1}{2}$-in. iron plates. The space for these sections is cleared and ties placed on grade. A cable is then looped around the section and the whole picked up by the digging teeth, on the bucket of the mucker, moved forward and dropped into place. The rails are then bolted together, the cable removed and the mucking proceeds as before.

Haulage

A German Diesel locomotive powered with a two cylinder Mercèdes Benz Diesel was first used. This motor was not entirely satisfactory as it could not run continuously without occasional breakdown. When the new storage battery motor was put into service it was possible to shut this Diesel down occasionally and thus keep it serviced a little better. During the early stages of the project shutting down the locomotive meant a tie up in tunnel driving because full time haulage of rails, blower pipe, air pipe, water pipe, etc., must be maintained in order that work in the heading might go ahead without interruption. Another disadvantage was that the Diesel exhaust, contrary to the claims of the makers, fouls the air quite a little. It does have the advantage of greater speed on the main line and is now used exclusively for main line haulage, the battery locomotive being used for switching cars in the heading.

Thirty pound rail is used on the main track. When the heading has advanced enough for the rear end of the Jumbo to be a rail length ahead of the first six foot section of forty pound rail, the sections are removed and a length of rail laid in their place. This work, as is most of the other work on pipes, surveys, etc., is done during the drilling cycle.

An attempt is made to carry the track about eight inches below the one half per cent grade line in order that it may be raised enough to put it out of the water if a heavy flow is cut.

Compressed Air

Air for drilling and steel sharpening is furnished by a 1,000 C.F.M. Pennsylvania compressor driven by a 175 h.p. Ideal synchronous motor. This machine is supplemented by a Gardner Denver "V" type compressor of 500 C.F.M. capacity driven by a 100 h.p. caterpillar Diesel through a short V belt drive. It might be mentioned that the electrical unloader on the Pennsylvania

machine has given a good deal of trouble and the machine has never delivered its rated capacity. Air is taken to the heading by a 4-in. pipe line, to which a length is added about twice daily.

The heading is ventilated by a 16-in. 4,500 C.F.M. Root Positive pressure blower which blows through 16-in. steel blower pipe. The motor to drive this blower was not installed until July 10, up to which time the only ventilation consisted of 3-5 h.p. centrifugal fans in parallel. The air forced through two thousand feet or more of 16-in. pipe by these fans was practically negligible, which makes the records made in speed of advance even more remarkable.

Electric power is furnished by a 300 h.p. Allen Diesel Engine and G.E. Alternator installed by Palidan Suyoc in the Suyoc Consolidated power house. This power is carried to the tunnel site at 4,000-volts. At the tunnel the line is split. A part is dropped by 3 Asea, 100 kva transformers to 440-volts for distribution to air compressor, pumps and other outside motors. The 4,000-volt line is carried into the tunnel to a 3-phase, 75 kva. G.E. " Pyranol " portable transformer which drops the voltage to 220-volts for the mucker. Power at 220-volts is carried to the mucker by about 1,200-ft. of G.E. Tellurium compounded cable. The transformer is moved about every 1,000-ft., the change requiring about 1½ hours.

A small light transformer is carried in the tunnel to provide current for the lights, which are spaced every 50-ft. along the entire length of the tunnel.

Timbering

In ground which requires timber a segmented arch which consists of three segments and plumb posts is used. Sets are placed on six foot centers. Posts and Segments are 10 in. by 10-in.—Collar braces 4-in. by 6-in.

As soon as the round is broken crown bars are placed from the last set to hold the back while mucking. As soon as the face is cleared up foot-blocks are placed on grade, being lined up from grade nails placed on the posts three feet above grade. The posts are then erected with a speader bar top and bottom and moved until on the center line. The posts are then blocked into place and the Jumbo brought into the face. The segments are then erected and blocked while the round is being drilled.

When the tunnel was started it was necessary to spile through the first 80-ft. or more of loose ground. This part of the tunnel and a little more, 90-ft. in all, was later concreted. This was a laborious job as the concrete had to be poured entirely by hand, no means of forcing it in under pressure being available. The last 1,500 or more feet has not required timber, it being in a fairly solid gabbro with only a few minor slips. A few places have been fairly well chewed up by more intensive faulting, requiring the placing of two or three sets of timber, but these places have been rare.

The operation is planned on the basis of two rounds each shift and, except in cases of breakdown, there has been little deviation from this plan.

After the round has been blasted, about 20 minutes is allowed for the smoke to be cleared from the heading before the men enter the tunnel. As soon as the heading is reached the mucker is moved to the face and a string of empty cars pushed onto the right side of the California switch. The locomotive is switched to the left side of the switch and an empty car is attached to the mucker. While this car is being loaded the locomotive is pulled up close so it can hook onto the loaded car immediately. The first car being loaded it is pulled by the locomotive onto the switch and an empty car hand trammed to the mucker. This switching is done very efficiently but it is felt that proper equipment for switching would probably cut down the mucking time by 30 to 45 minutes. As soon as room is cleared for it, a new section of track is put down, the operation requiring perhaps five minutes.

Time required for mucking averages about 1¾ hours.

If in ground that requires timber, the plumb posts are stood and blocked in place while the locomotive takes out the loaded cars and bring up the Jumbo, which is kept on a second California switch about 1,000-ft. from the face.

As soon as the posts are blocked in place the Jumbo is pushed into the face and the segments are put in place and blocked from it while the drills are running.

Practically all of the incidental work in the tunnel is done during the drilling cycle. This work includes the daily moving of the California switch, laying of track, hanging blower pipe, stringing light and blasting wires, the twice weekly extension of the survey line and the occasional moving of the second California switch and the 220-volt transformer.

Drilling as a rule requires about 1½ hours for an eight foot round. If the ground requires much timber the round is drilled a little shorter in order to make up the time lost in timbering.

There have been a few occasions in which three complete rounds have been made in a single shift. On one day when the locomotive was under repair for sixteen hours the graveyard shift turned in an advance of 24-ft. for that shift alone.

The speed of advance has been above expectations and it is felt that in view of the untrained labor world records have been broken by a large margin.

The month of June was the first full month during which the mucker was in use and a total advance of 1,088-ft. was made. It must be remembered that this was made with practically no ventilation.

The month of July showed the best progress which has been made. During this month about four days were lost in breakdowns, chiefly of the locomotive and the compressor. However, in spite of this lost time an advance of 1,327-ft. was made.

W. H. Allen and Sons Diesel Engines in Suyoc Power Plant

The best day so far is July 31, on which date an advance of 58-ft. was made. The best week accounted for 341-ft. This all in rock tunnel, mostly without timber.

The 7,094-ft. of tunnel driven to date has resulted in no deaths, no haulage accidents and only four minor lost time accidents. When one considers that this record has been made with a class of labor which is not only unused to machinery but contemptuous of its potential danger and often ignorantly foolhardy, it is the more remarkable. Constant vigilance is observed by the shift bosses in an attempt to prevent accidents, although very few rules have been laid down.

Statistics

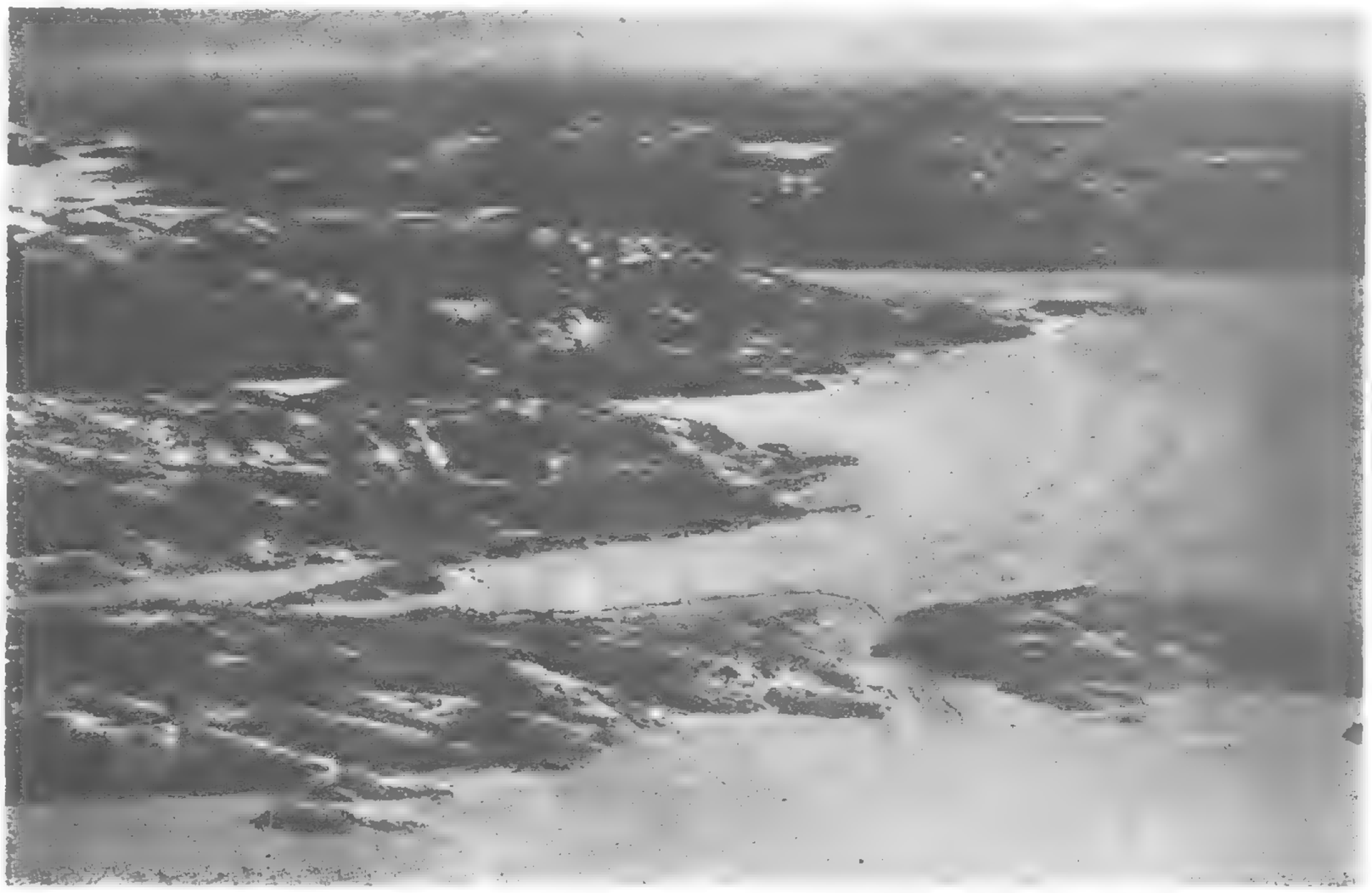
Costs in the driving of this tunnel have been low as compared to costs in similar tunnels in the United States. The costs presented in the following table are exclusives of depreciation but includes all other items of operating expense, including very generous footage bonuses paid to the men, P.1.00=U.S. $0.50.

	May	*June*	*July*	*August*
Breaking	P.13.28	P.15.84	P.18.65	P.19.23
Mucking	7.49	1.69	1.74	1.81
Timbering	4.60	3.91	0.67	1.11
Haulage (Tramming)	4.55	2.07	2.55	3.14
General Expense	5.14	2.89	3.96	3.08
Engineering	0.47	0.19	0.16	0.16
Ventilation	0.01	0.02	0.09	0.11
Bonus for footage	5.75	9.43	11.33	10.21
Totals	P.41.29	P.36.04	P.39.05	P.38.85

A large part of the general overhead expense is that of keeping open for traffic a 7½ kilometer road from the Suyoc Consolidated

(Continued on page 74)

Radium Industry on Great Bear Lake in Northern Canada



The World's Radium Capital near the Arctic Ocean where the richest radium deposits in the world are located. In the center foreground is La Bine Point where the deposits are found. Behind its hills appear the mill and camp of the Eldorado mine. The lake is navigable on 50 days in the year and terrific winds prevail. The water is never above 34 degrees F., but that does not bother the trout which grow to 40 pounds in weight. Winter temperatures reach 65 degrees below zero

THE process of recovery of radium from ores containing silver and pitchblende taken from the Great Bear Lake mines is described by M. Pochon in *Chemical and Metallurgical Engineering* for July, and reprinted in the August issue of the *Mining Magazine*. The refinery itself is situated at Port Hope, Ontario, and here, after mechanical concentration at the mine, four types of product are delivered. These are :—(1) A hand-picked lump ore, (2) a $\frac{1}{4}$-in. jig concentrate, (3) a 14-mesh Wilfley concentrate, and (4) a finer Deister concentrate. The presence of a valuable amount of silver mixed with the pitchblende presented the plant with a special problem, because it was imperative to have a single process of treatment efficient for both silver and radium recovery and suitable to all types of ore produced at the mine. A great deal of experimental work had to be done before a definite method could be adopted.

Chemical operations were commenced at Port Hope in January, 1933, following a procedure already investigated in the Canadian Mines Branch at Ottawa. At first it was thought advisable to remove the radium, letting the silver accumulate in the residues, finally to be recovered by smelting. Some difficulties were experienced, however, due to the large amount of silver hindering the filtering operation and, after three years of experimenting, another process was developed in 1935, again with the collaboration of the Mines Branch. This process is now in constant operation at the plant and provides for the removal of the silver early in the work, followed by the recovering of the radium. Treatment of 150 tons of pitchblende, with 1,550 oz. of silver per ton, was successfully completed in 1936, giving evidence that the process was efficient and economical.

The process consists of four different operations, which are housed in separate buildings at Port Hope. These are : (1) The preparation of the minerals by roasting and milling, (2) the recovery of silver and the reduction of the radium into radium-barium sulphate (3) finishing of the radium in the laboratory and, (4) refining of the uranium salts.

ROASTING AND MILLING.—Since the pitchblende concentrate received at Port Hope from the Great Bear mill is the product of a gravity concentration process, it contains, in addition to the uranium and silver, other heavy metals as impurities. These are mostly arsenopyrite, chalcopyrite, galena, cobalt, and bismuth minerals. Also present are some of the gangue materials, like quartz, hematite, barite, calcium, and manganese carbonates. The pitchblende is by far the most abundant mineral. The concentrate contains from 35 per cent to 50 per cent of oxide of uranium and from 1 per cent to 7 per cent of silver, according to the section of the mine from which the ores are taken.

In the first stage of the wet processing of this ore, a strong sulphuric acid treatment is used. Since the sulphides and carbonates cause much gassing and foaming it was found necessary to give the ore a preliminary roasting. The hand-cobbed ore is first crushed in a rock-breaker to about $\frac{1}{4}$-in. mesh, mixed with the finer classified ore, and fed to a Herreshoff furnace mechanically rabbled and kept at about 1,100° F., while a good blast of air is maintained into the furnace. This decomposes the sulphides and carbonates and eliminates some arsenic and antimony by volatilization. The operation is continuous, with a circulation of about 110 lb. of ore per hour. A dust collector is attached to the stack of the furnace and recovers about 50 lb. of fine dust per 24 hours.

Since the silver is present mostly as native silver, the usual method of wet extraction by a solution of sodium cyanide or hyposulphite is not suitable. To make it extractible the ore is re-roasted with salt to transform the silver and uranium into chlorides. The salt is mixed with the product of the oxidizing roast in proportion to its silver content. In practice 5 per cent to 10 per cent is used and the salt roasting is done in a reverberatory furnace, hand rabbled, taking four hours for a charge of about 350 lb. The temperature

Camp of Eldorado Gold Mines, Ltd., on Great Bear Lake. In foreground is bunkhouse with steam heat, electric lights, hot and cold running water. Fuel tanks, mill and power plant are in background

is kept as low as possible to avoid losses of silver chloride as a result of volatilization. The chloridized product, after discharge from the furnace, is allowed to cool and is ground in a rod-mill, passed through a 40-mesh screen, and bagged. It is now ready for the wet process. The 40-mesh size is sufficiently fine for a good contact with the chemicals and coarse enough for the filtration during the following steps. Each 100 lb. of raw ore gives about 97 lb. of roasted product from the Herreshoff furnace and about 104 lb. of ground ore after the salt roast.

The roasting and milling operations are carried on continuously for every car of 40 tons received from the mine. The furnaces are then shut down for a day or two for clean up and repairs. Sampling is done on every batch of five tons of ground ore. A liberal sample is taken to permit complete assay and other laboratory tests of the various operations of the process which will be followed three to four weeks later when that particular batch is subjected to treatment in the plant.

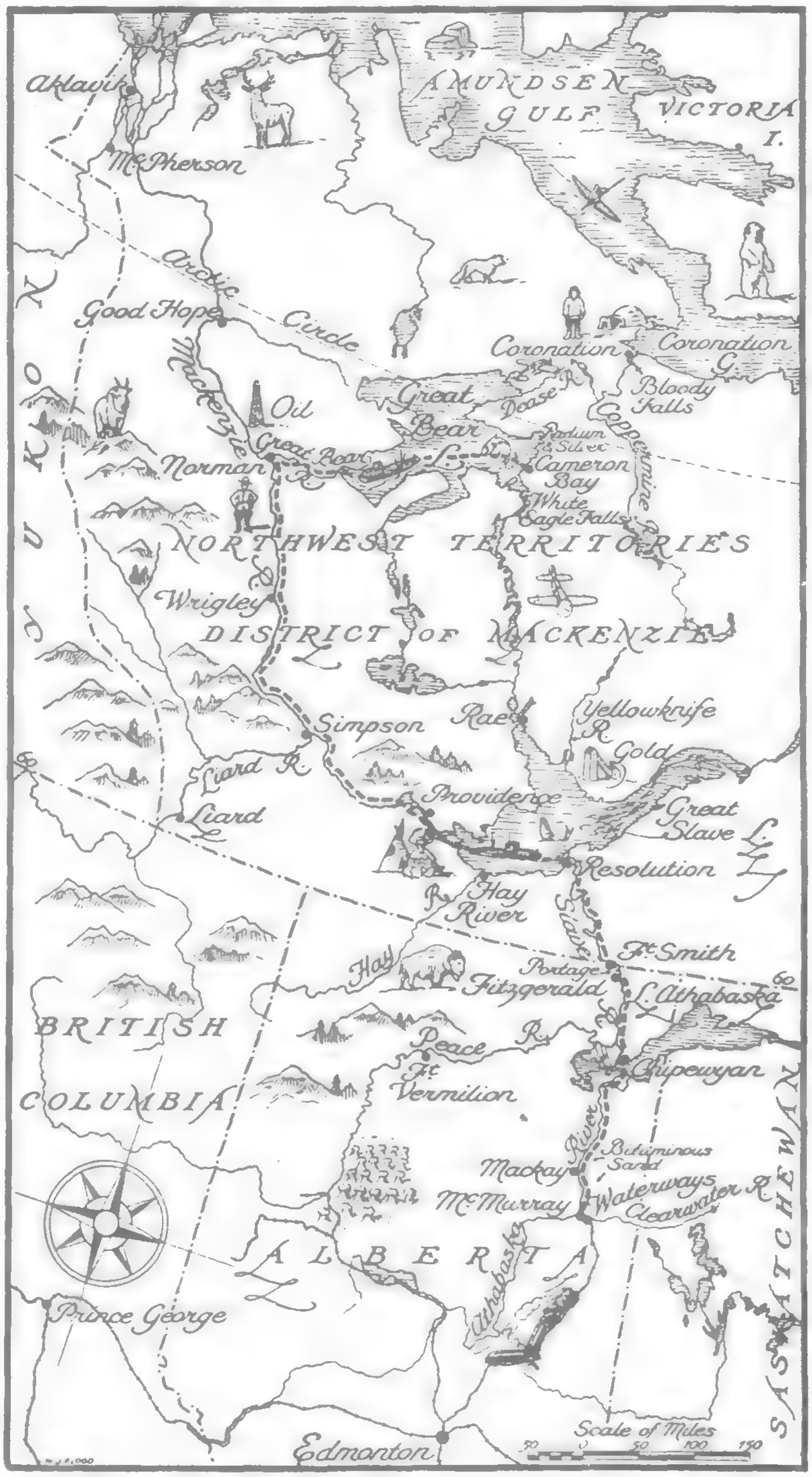
SILVER RECOVERY AND RADIUM REDUCTION.—The first step in this series of operations is leaching with sulphuric acid, followed by filtration. About 420 lb. of ore is leached for six hours in a stoneware leacher, using sulphuric acid diluted one for one with water. The ore contains only about 0.5 per cent of barium sulphate, which is scarcely sufficient to act as a carrier for the radium. An equal quantity of barium chloride is therefore added during the leach. During the second hour about 5 per cent of sodium nitrate is also added in order to oxidize the uranium solution. At the end of this operation a few pounds of hydrochloric acid is added to take care of any soluble silver. After filtration in a stoneware suction filter an insoluble residue is separted and a filtrate of crude uranium sulphate is obtained, containing as impurities iron, copper, manganese, calcium, and some other soluble metallic compounds. This filtrate is transferred to the uranium refinery.

The insoluble sulphate residue contains the radium, barium, silver, lead, silica, and some calcium. It is assayed for silver, then agitated in a steel revolving drum for three hours with the necessary quantity of sodium hyposulphite. After filtration and washing in a suction filter the insoluble residues are extracted and the filtrate of silver liquor is precipitated with sodium sulphide. The silver sulphide is passed through a filter press, dried, ground, and shipped to silver refineries in the United States. This silver sulphide contains an average of from 75 per cent to 80 per cent of silver metal, with a small amount of impurities such as iron, lead, bismuth, arsenic, and antimony.

The residues from this hypo leaching usually contain from 12 per cent to 18 per cent of lead sulphate and they are now treated for the extraction of the lead. This is done by boiling in an open steel kettle for 1½ hours with caustic soda and filtering, first in a filter press, and then completing the washing of the insolubles in a battery of pressure filters. The lead eliminated in the solution is not recovered commercially. About 98 per cent to 99 per cent of the lead is removed and also a certain amount of silica.

The insoluble residue now contains silica, radium, and barium. It is boiled with soda ash in a steam-jacketed autoclave for six hours under low pressure. The carbonated material is filtered and the washing of the cakes finished in a battery of pressure filters. The cakes are placed in stoneware kettles, acidified with a strong solution of hydrochloric acid, and boiled. Filtration on stoneware suction filters follows, resulting in a residue of silica containing too little radium to be of practicall interest and a filtrate consisting of the barium and the radium-chlorides. This chloride liquor is pumped to a set of stoneware precipitators, which are agitated with a slight excess of sulphuric acid for six hours. After settling, the sulphate concentrate is drawn off, filtered, and washed. It is then delivered to the finishing laboratory for further treatment. The precipitate is composed mostly of radium and barium sulphates and carries some impurities of lead, calcium, iron, and silica. The quantity of ardium-barium concentrate produced is about 1.5 per cent of the weight of the original ore treated, giving a reduction ratio of about one ton of sulphate for 66 tons of ore.

For each 100 lb. of ore treated the weights of the various insoluble residues obtained during the series of operations are as follows: After sulphuric leaching, 35-40 lb.: after hypo leaching, 30-35 lb.: after caustic soda leaching, 20-25 lb., and after soda ash and muriatic acid, 10-20 lb. Some highgrade silver and pitch-blende ore treated at the plant has left the final residues amounting to only 6 per cent.



Map showing water route followed by foster wheeler boilers going out to the mines and by concentrated radium ores coming in to the railroad for shipment to the refinery, eldorado mines, La Bine Point and Echo Bay are adjacent to Cameron Bay as indicated

The processing equipment used in these stages at Port Hope is simply large-size laboratory units. The extremely high content of radium in the ore requires that only small lots be handled at one time and recovery and washing must be unusually complete. The final residues are maintained at about 3 mgms. of radium per ton and about 25 oz. of silver and their re-treatment is no longer economical or practical. The percentage of recovery for the silver is above 95 per cent and over 90 per cent for the radium. The finishing of the radium proceeds as follows :—

The radium-barium sulphate concentrates are transferred from the plant to the laboratory, where they are changed to carbonates by boiling with soda ash in steel kettles. After filtration and washing, the carbonates are acidified with hydrobromic acid and the bromide liquors purified for removal of the lead, iron, copper, etc., using barium hydroxide and barium suphide as purifying agents. All impurities and insoluble residues are collected and when a certain quantity has accumulated they are treated again with sulphuric acid, soda ash, and hydrobromic acid and the purified solution added to the bromide liquor already available. The final

residue still contains a little radium. It is, therefore, sent back to the leachers at the beginning of the wet process.

Separation of the radium from the barium is effected by fractional crystallization, using the differential solubility of the radium and barium bromides in water. The purified bromide liquors are evaporated to saturation and allowed to cool. A crop of crystal comes out in the bottom, richer in radium and poorer in barium that the liquor above it. The operation is repeated separately on the crystals and on the solution in a system of quartz basins and Monel metal pails to insure an even flow of sucessively richer and richer radium bromide in the crystals and poorer and poorer barium bromide in the liquors. The initial bromide solution has a ratio of about one part radium to 400,000 parts of barium. The head crystals, after ten crystallizations, show one part of radium to about 600 of barium. These crystals are separat-from the system and accumulated for about a month. They are then re-purified in the same way as the original liquor and the crystallization is carried to a point where the ratio is nine parts of radium to one of barium. The crystals are then dried, transferred into glass tubes, and sealed therein by a blowtorch.

The filtrate from the acid solution of the ore (first stage in the wet processing of the rosted ore) is pumped to a separate building for the refining of the uranium. This liquor is treated with an excess of sodium carbonate which dissolves the uranium as sodium uranyl carbonate and precipitates the iron, manganese, and most of the copper. The sodium uranyl carbonate liquor, after settling, is decanted to other tanks and decomposed with sulphuric acid. Caustic soda is added to this to precipitate a crude sodium uranate. This crude product is removed in filter presses, dissolved in sulphuric acid, and small impurities precipitated by additions of sodium sulphide. The clear filtrate from this operation is freed of hydrogen sulphide and sulphur and sodium hydroxide is added to precipitate the orange or yellow sodium uranate of commerce. This product is washed, pressed, dried and ground, bagged, and shipped to the consumer. The difference in color between the orange and the yellow products is due to the different amounts of caustic soda used for the precipitation, the orange requiring an excess of caustic.

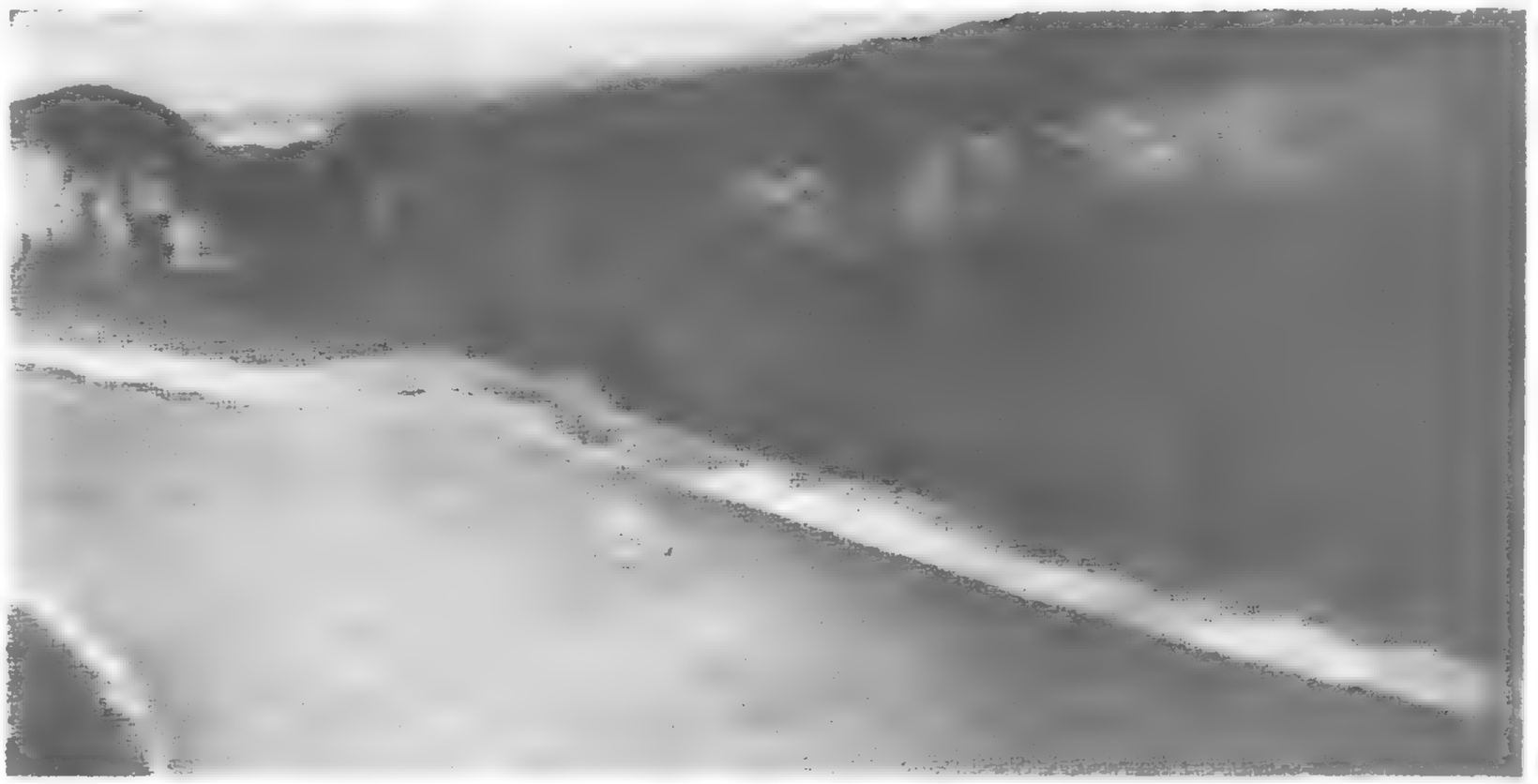
Black oxide of uranium is made by dissolving purified sodium uranate liquor and precipitating with ammonium hydroxide, washing, drying, and burning in crucibles in an electric furnace. Ammonia is driven off and a reduction of the material effected to give the desired compound. Uranium nitrate is made by solution of the oxide in nitric acid and crystallization of the product from water in large porcelain trays. Uranium acetate is made by solution of the hydrate in acetic acid and recrystallization from water.

* * *

Boilers in the Arctic

Interesting transportation problems involving heavy Foster Wheeler equipment have recently included 600 miles across the desert of Iraq, the flying into central Canada of boilers by air, and now comes the barging of boilers along streams and rapids up to the Arctic Circle.

The Eldorado Gold Mines, Limited, mining the world's richest radium-bearing ore, and located on Great Bear Lake in the Canadian North West Territories, only 200 miles from the Arctic Ocean, has recently installed two boilers. One is a 60 h.p. welded, wood-burning boiler for 100 lb. operating pressure and the other is a waste heat, extended surface boiler designed to absorb heat from the exhaust gases of three Diesel engines rated at 307 h.p. 295 h.p. and 186 h.p., respectively. The boilers are used in the plant where crude ore, or pitchblende, is concentrated before being shipped a distance of 4,000 miles to Port ape, Ontario, for refining.



Air view of Bear River and Mount Charles (elevation 1,500 feet) showing power barge with scow entering rapids. Note effect of ice action on shores

Transportation of the completely assembled boilers has been handled by the Northern Transportation Company, a subsidiary of the Eldorado Gold Mines. The boilers were shipped by freight over the Canadian National Railways to Edmonton and then over the Northern Alberta Railways to Waterways, where the long water journey began. From Waterways, a barge carried the equipment 300 miles down the Athabasca River, across Lake Athabasca, and down the Slave River to Fort Fitzgerald. At Fort Fitzgerald are dangerous rapids, known as "the Rapids of the Drowned," which resemble a "water lubricated staircase." A sixteen mile portage had to be made around the rapids. This was followed by a second barge journey of 850 miles from Fort Smith down the remainder of the Slave River to Great Slave Lake, across the lake and down the broad Mackenzie River to Fort Norman. At this point the Bear River flows into the Mackenzie. From here a third barge of shallow draft carried the equipment up the Bear River 75 miles through some severe rapids to Fort Franklin. Another transfer was then made to a fourth and last barge for the final stage of 200 miles across Great Bear Lake to the Mines on Echo Bay—in all, a journey of 2,000 miles from Edmonton—Edmonton being, actually, only 1,100 miles away by direct distance.

The remarkable aspect of this installation is that it forms part of a modern exploration and discovery, completed only in 1930, that culminated in a reduction of nearly two-thirds in the world price of radium. Alexander Mackenzie who first sailed down his famours river to the Arctic in 1789, Captain John Franklin and Sir John Richardson all had established camps on Great Bear Lake, but it remained for Dr. Camsell and the late Dr. McIntosh Bell, of the Geological Survey Branch of the Dominion Government, in 1900, to make the first recorded exploration of that huge lake, the largest in Canada and one-quarter the size of England. The approach of winter forced the two explorers to hasten south without investigating all that they saw. In Dr. Bell's report, written in 1901, are the words: "the steep rocky shores, . . . east of McTavish Bay (at the eastern end of Great Bear Lake) . . . ., are often stained with cobaltbloom and copper green." This report lay buried in the archives until 1930 when an experienced Cobalt prospector, Gilbert La Bine, happened to read in it these words and recognized their significance. He went immediately by airplane to the location described, now known as La Bine Point, and brought back samples of ore for examination by the Canadian Mines Department. It proved to be very high in radium content, yielding one gram per 6½ tons of concentrated ore, with considerable silver also present. Concentrates in the United States, that had led the world production between 1912

(Continued on page 74)

Towboat "Radium King" with sister "Radium Queen" tows barges full of Uranium concentrates 1,400 miles to the nearest railroad

Manchuria's Super-Express "Asia"

(From Contemporary Manchuria)

ANSWERING the call for speed and comfort in railway transportation of to-day, the South Manchuria Railway Company placed at the service of Manchuria its latest creation, the ultra-modern stream-lined super-express *Asia* which made her "maiden voyage" on November 1, 1934. Faithful to its name *Asia*, christened by Count Hirotaro Hayashi, then President of the South Manchuria Railway Company, this new speed demon is well representative of all Asia in technical skill, construction, operation, convenience, and comfort. It is a masterpiece in the creation of which the railway experts spared nothing in order that railway science of the Far East be "put on the map."

Dashing through the vast plains of Manchuria at a terrific speed, the *Asia* negotiated the distance of 701.5 km. between Dairen and Hsinking in 8½ hours on the initial trial run, producing an average rate of 82.5 km. per hour. The present steam engine world's record is held by the *Flying Scotchman* and the *Paris Golden Arrow* which cover 94.2 km. and 87 km. per hour respectively, but the 83 km. record of the *Asia* is only a trifle less than those of the European iron monarchs.* The fastest Japanese super-express *Tsubame* (Swallow) can do no better than 68 km. per hour, although in Japan, the 3-ft. 6½-in. gauge does not permit a higher speed. In fact, the management is looking forward to the attainment of a higher speed by their streak of lightning, if not to pale the existing records into insignificance. With zest and zeal, workmen are hammering away at the road-beds in an effort to adjust the present bed, curvings and grades to the facilitation of a higher speed run. Should the energetic adjustment program be completed, all Asia would triumphantly hail still higher, the unrivalled feat of the South Manchuria Railway's shooting star. Potentially capable of hitting 140 km. per hour (it must be remembered that the actual operation speed is 83 km. per hour or only 59 per cent of the highest attainable rate), there still remains a comfortable margin for higher acceleration upon harnessing *Asia's* reserve power. It may not be possible to attain the maximum speed, but it is not impossible nor improbable for the *Asia* to shatter the records of the present Scotchman or the Parisian in the near future, and thus acquire for itself and the Far East, the speed laurels of the world's "track" event.

However, much improvement must still be made before one can expect to see the blue ribbon vested in the hands of Manchuria. As mentioned above, the road-bed, curves, and grades between Dairen and Hsinking require extensive reconditioning, and completion of a further task is necessary, that of extending this work on the Hsinking-Harbin section where standardization of the gauge (5-ft. to 4-ft. 8½-in.) has been completed on September 1, 1935. The conditions on this line are so poor that even the super-transport *Asia* is compelled to do no better than 30 km. per hour on the average, when it undertook the entire run from Dairen to Harbin upon standardization. In consequence, the 83 km. average established on the 701.5 km. course between Dairen and Hsinking was reduced to 75.5 km. per hour when the express took 12½ hours to cover 943.4 km. between Dairen and Harbin. Nevertheless, no other train in Manchuria can make a faster run than the *Asia* for the *Hato* (Pigeon), in itself a formidable express, was compelled to take second place, the difference in time between the two being two hours on the Dairen-Hsinking run. The *Asia* will be worthwhile watching when the gigantic renovation program now under way is completed.

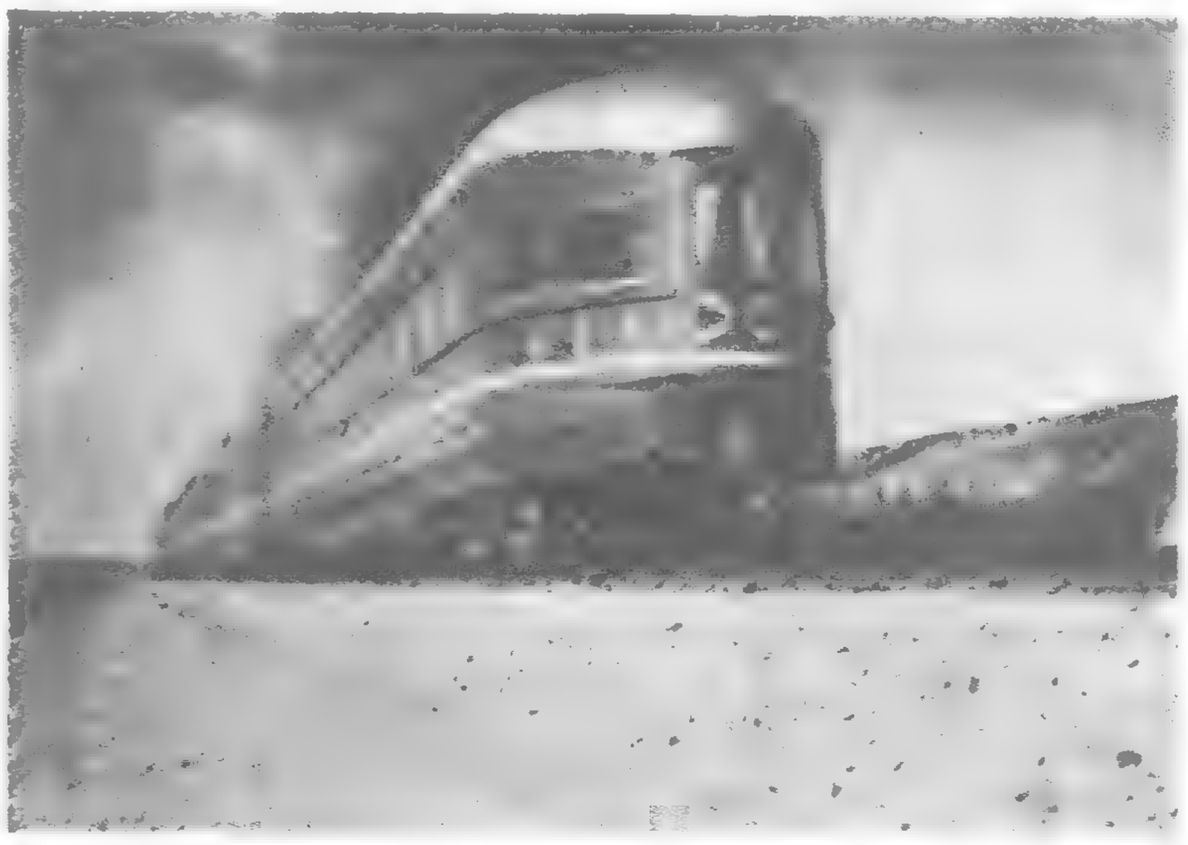
Outward Appearance

Since the recent inception of stream-lining, this technique and appearance has become the fad in modern railway design, as well as in ships, planes and even bicycles throughout the world. Experts assert that the reduction of air resistance around the wheels remains unaltered though frontal resistance is tremendously lessened, unlike the happy effect of stream-lining on aircraft. Nevertheless, it gives a pleasing appearance in design, and is especially befitting the elongated body of a fast express train. Not to be left behind, Manchuria did not hesitate to be in vogue, and embodied this quality in the construction of the *Asia*.

So we find this Asiatic wonder stream-lined from head to tail, giving a majestic and stately, yet grotesque appearance. Both ends are wedge-shaped, the roofs are gracefully arched, and a white streak runs the entire length of the dark green colored body of the train (six cars in all) just beneath the perfect alignment of "port holes." So identically are the two ends shaped that it is quite difficult for anyone to differentiate between the locomotive and the rear-most car. "I'll chew my cap, if you can tell which end the *Asia* will start moving," a proud uniformed conductor was heard wagering with his friend at the Dairen station platform one day, pointing to the sleek, crouching form of the super-express about to start on its dash to Harbin. Unfortunately, the writer was unable to witness the outcome of this confident wager, but he is quite certain the conductor did not have to "chew" his cap. So identical are the two ends of the flying comet that there is an equal chance of one pointing at the locomotive and calling it the last car, or taking the observation car for the head of the train. Many a spectator has met disappointment in finding that the *Asia* began moving from the "wrong end." So complete is the stream-line

* There are other speedy expresses like the *Bullet Express* of the American Union Pacific Railroad, put in service in 1933, which runs at an appalling rate of 190 km. per hour, but they are not run by steam power.

Manchuria's speed demon, the "Asia"



The stream-lined "Asia" seen from rear

Interior of first class passenger car of the super-express

Interior of second class passenger car. Note position of swivelled chairs

effect that to the ordinary man, the *Asia* can begin running from any end and attain the high speed of a hundred kilometers, unless the strikingly stubby but betraying funnel of the locomotive, and the protruding tail light of the rear-most car arrest the attention of the casual observer.

The fastest train in the Orient as well as the most modern and efficient in every department, she is a thing of beauty.

Component Parts of the "Asia"

The super-modern *Asia* is composed of six cars besides the locomotive. They take the following order:

Locomotive—baggage and mail car—third class passenger car —ibidem—dining car—second class passenger car—first class passenger and observation car.

From tip to tip, the entire train measures 147 meters or roughly 480 feet. Being a limited express, accommodation under normal conditions is restricted to 304 persons, or a seating capacity of 176 third class, 68 second class, and 60 for first class. Should the demand for more seating arise, either an additional first or second class car could be attached between the last two cars.

The Engine.—In order to insure maximum speed and yet to maintain the minimum dead weight possible, especially with the installation of the mighty 2,400 horse-power engine, much experiment and consideration were accorded in the construction of the locomotive. In consequence, the axle weight was considerably limited by the use of cast steel for the cylinder, nickel steel platings for the boiler, high quality cast steel for the main frame, and aluminium alloy for the brake cylinders, cylinder front covers, as well as all oil and grease cellars.

In general, the locomotive was modelled after the American fashion, but much ingenuity was incorporated in adapting the fire box to the use of Fushun coal together with other adaptations to Manchurian peculiarities.

Due to the special importance in connection with lubrication of so intricate a mechanism, upon which is placed the reliance for the attainment of high speed, much attention was given to produce an engine capable of making long stretches but requiring the least lubrication attention. It was found that soft-grease-forced lubrication was best suited for the brass and hub of the driving journal and oil-forced lubrication in the engine truck, guide bars, link block, etc. The soft-grease lubrication is also applied to the main and side rod, and the other crank pins, by the use of the floating bruse.

The problem of designing and installing the streamlined cover on a locomotive that fulfils its purpose without affording any hindrance to daily inspection, boiler washing, or general repair and adjustment operations, is a difficult one indeed. However, satisfactory results were obtained on the "power-house" of the *Asia* enabling smooth and unobstructed performance of all operations, and at the same time the installation added much to the formidable and fleet-footed appearance of the train.

Baggage and Mail Cars.—This car is of the six-wheel bogie type with a wide vestibule on each end and a rounded roof. There is a mail room on one end of the car, which is adjoined by a mail distribution room. On the other end is an officers' quarters and the mail distribution room is in a baggage room, with a lavatory in one corner adjacent to the mail distribution room.

Passenger Cars.—The locomotive was not the only member that received stream-lining and weight-saving attention. These elements were likewise embodied in the construction of the passenger cars to attain the identical aim, speed, although an additional consideration is the matter of comfort, which is no less important in comparison with the former factor, in passenger cars.

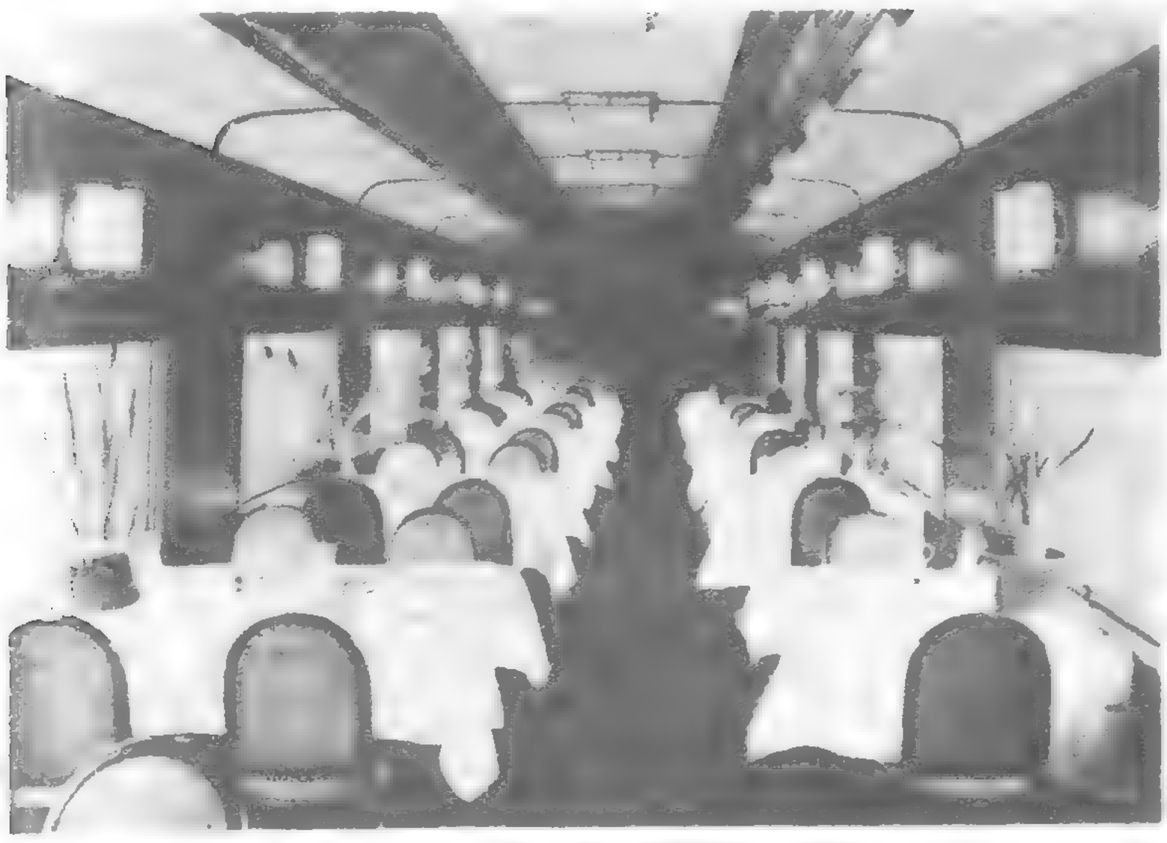
The train as a whole, therefore, constitutes a perfect streamlined unit to neutralize wind resistance and gain higher speed in concert with the light weight construction of the body, which is built of light aluminium alloy and magnesium as much as possible. The important frame works are reinforced with high strength steel, and the sectional areas of the structure are retrenched, while welding has been employed as much as possible to insure further lightening.

Special care was taken in building the structure not only to prevent external vibration from invading the interior, but also to eliminate the possibility of the car's own vibration turning into noise. Rubber heels are attached to all important points for shock absorbance to further reduce vibration. Due to these special appointments to effect smooth running, a ride on the *Asia* is a little short of gliding motion. When the giant British Cunarder, *Queen Mary*, was placed on her run, the company management is said to have boasted the smoothness and steadiness of the huge ship's hull on the high seas at tremendous speed. So steady is the ship that "not a drop of water can be spilled from a glassful." Our *Asia* is just as smooth on the run, if not steadier. It is so free from vibration that one can "shoot" time exposures on board.

The third class passenger cars (two in number) are of the six-wheel bogie type, with wide vestibules on both ends. A lavatory and a wash room are located on each end, next to the vestibules. Large cushioned double seats as good as those on the *Hato's* second class, and capable of accommodating 88 passengers to the car, line both sides of the wide aisle that runs through the middle of these rows of seats, which are so placed that they face each other.

The Dining Car.—Maximum floor space has been arranged to facilitate comfortable and spacious servings. With this purpose in mind, the platforms are omitted on both ends of the car. One end, however, is used for a waiting room with seats available for six persons. This compartment is partitioned by a sliding door from the main dining "hall" which can serve 36 passengers at a single sitting. Facing the dining tables are located the cashier's stand, a refrigerator, and a cabinet, while the remaining space is occupied by a pantry and a kitchenette equipped with a heavy oil range. Meals are served table d'hôte as well as *à la carte*; table d'hôte charges are Y.1.50 each, both for lunch and dinner.

The second class passenger car is of the six-wheel bogie type with a wide vestibule on each end and a rounded roof. A Japanese style lavatory and a wash room are placed on one end, while on the other are located a combination lavatory and wash room, and stewards' quarters and lockers. Seventeen double seats line the main section of the car, separated by a wide aisle. There is a special



Interior of the dining car of the "Asia"

Observation car on the super-express

convenience attached to the installation of these seats. At a push of a button fitted in the front face of the seat's bottom, the chair moves outward to a position of 45 degrees from the original, and enables the fullest enjoyment of passing scenery. This idea of swivelled chairs is indeed a novelty, adding much to the convenience and comfort of travellers. Those of the third class are fixed to the floor, a factor that constitutes the main difference between the two classes. Seats of the first and second class cars are fitted with cushion springs made of piano wire and plush coverings. Those in the first class car are double cushioned and fitted with silk velvet coverings.

There is little difference between the first class car and the second class car in the matter of construction. A ladies' toilet and wash room occupy one end of the car, while on the other is located a men's lavatory, a wash room, a conductor's compartment, a parcel closet, and a set of lockers. There are fifteen revolving double seats on either side of the central aisle, capable of seating 60 passengers.

The first class observation car which constitutes the last link of the chain, is divided into an observation parlor, seating section, a special room, and a group of adjoining compartments. Inevitably, the observation parlor occupies the tail end of the entire train, but the familiar platform seen in other express trains, is entirely lacking. Instead the rear-most end merges into a pointed stream-line resembling the sleek appearance of the cruiser stern. Reading and writing facilities are provided on one end of the parlor toward the frontal direction, and next to this is found the passenger section equipped with revolving double seats for 30 passengers. Adjoining this section is a special room furnished with a sofa and two arm chairs, while it is neighborhood by a wash room, toilet room for women, a men's lavatory, parcel closet, a steward's compartment and a closet.

General Construction.—Side posts of the cars are built of pressed steel plate and firmly riveted or welded against both the cant and belt rails, which are made of special high strength steel. The steel plate used for the side panels is only 1.5 mm. in thickness above the belt rail. For the interior panel, veneer is mainly employed except in the baggage and mail car, and over this veneer, a panel of walnut, maple or elm is used. A hair felt 25 mm. thick, and a flannel sheet are filled in between the boards of the side walls to act as heat and sound insulators.

The floor is double plied, the top being laid lengthwise, and the lower diagonally, between which two sheets of paper boards are sandwiched. Japanese ash wood is used for flooring in the baggage and mail car, and American timber on the other cars. Either carpets, rubber sheets, or linoleum are laid on the flooring according to the different classes or purposes of the rooms and cars.

A steel roof sheet of 1.5 mm. thickness and a veneer board of 5 mm. are used for the roof and ceiling, with sound and heat insulation layers similar to the wall construction. Steel and wood carlines are distributed at several points with a couple of steel purlines placed lengthwise.

All the windows are of glazed double metallic-sash, intended for raising movement only. Burnished glass is used for the windows of the second and first class passenger cars, and morocco glass for lavatories and wash-rooms.

Since the cars are completely air conditioned, the windows are usually kept closed, but in case of necessity, they can be opened with keys held in custody of the conductor. The bevel gear system is adopted for the windows of the second and first class passenger cars. Just inside the window post felt is placed for the adjustment of clearance as well as the prevention of leakage of draft and rain. For the further prevention of dust infiltration, weather strips are carefully fitted in on the outside of the windows. Each window is equipped with a roller blind, outside of which is applied a coat of aluminium powder to deflect sun rays.

Moreover, much attention has been centred in the distribution of maximum sunlight into the interior of the passenger cars to give a gay and delightful atmosphere.

Every vestibule has on either side, a suspending and sliding entrance door made of light alloy, with a glazed window in the upper half. Besides being a hinged trap-door, it is so constructed that when closed, it may securely be supported from all sides, and absolutely insured against loosening. A hand brake is installed in all vestibules for emergency use, while the ordinary brakes are all Clasp Brakes of the American Westinghouse LN type.

At each junction of the cars, double diaphragms of the same shape as the cross-section of the cars, are installed just outside the vestibule to prevent the inrush of air current caused by the valley between cars. A fire-proof cover is placed over the outer diaphragm.

Air Conditioning

Since air conditioning is one of the most important factors to be reckoned with in train travel of long stretches, especially under Manchurian climatic conditions, a special section is allocated here for its treatment. Much is added to the comfort of passengers of the *Asia* due to the special apparatus and system for maintaining the equilibrium of air conditions within the cars.

Based upon past experiences with older express trains, an improved model for use on the *Asia* was constructed with attendant efficiency and satisfaction throughout the four seasons.

The difference between summer and winter conditions of Manchuria is extremely marked. In both seasons, the air is rather dry, due to scarcity of rainfall, while in the spring the atmosphere is filled with dust particles. Under these conditions an effective air conditioning instalment is vitally important to eliminate unhealthful exposure to dry air, heat or cold, as well as to the invasion of soot and thick dust clouds.

The air conditioning apparatus on the *Asia* takes care of heating, cooling, ventilating, and purification, maintaining automatically a set temperature and humidity throughout the four seasons.

Cooling operations during the summer months are performed by the Carrier steam jet refrigerating machine. When water pressure declines, water begins to evaporate at a low temperature, and thus lowers the boiling point, a process which utilizes the physical property of water. In other words, steam with a pressure of approximately 3.5 K8/cm is ejected from the steam nozzle, inducing air and vapor in the evaporator which is heat insulated, and produces and maintains a high vacuum. As the result of these processes, water is cooled by evaporation.

The refrigerating unit has capacities of six and 7.5 tons. Second and third class cars are equipped with 7.5 ton units, and the others with six ton units. It is possible to send cooled water of 7° to 10° centigrade from the refrigerating unit placed under the floor to the air-cooling coil installed in the car's ceiling, by means of the cold water circulating pump.

Outside air as well as recirculated air is filtered through the air filter, after it is cooled and dehumidified by the air cooling coil, following which, this cooled and dehumidified air is equally distributed throughout the cars by means of the air duct.

Temperature of the air outlet grill during the warmest season is around 15° centigrade, and a current is maintained at all times, although it is not noticeable to the passengers. Interior temperature is regularly adjusted by a thermostat.

In the winter, the direct system floor heating, and warm air heating are employed. Three different temperatures can be attained, namely, 18°, 20° centigrade, adjustable to any of these temperatures by a mercury thermostat. Through the functioning of a hair type hygrostat, the steam supply to the humidifier is controlled, which enables the maintenance of a set percentage of humidity. At times when heating or cooling is unnecessary, outside air is ushered in by means of a fan.

Interior air is composed of 25 to 30 per cent outside air and from 70 to 75 per cent recirculated and purified air. This results in the ejection of air, equal to the volume pumped in from the exterior, which escapes through the crevices of windows and doors.

Heating, cooling, and circulation are accurately controlled by a switch located in the air conditioning control panel, and the motive power is supplied by the 8 kw. generator which generates electricity by the revolutions of the wheels.

There are many complex technicalities involved in regard to the operation and functioning of the air conditioning device. Thanks to the careful and thoughtful consideration given by the authorities of the South Manchuria Railway Company, and to the wonderful achievement of expert technicians, travelling on the *Asia* has been much simplified, eliminating irritations arising from heat, cold, dust, or draft. Any month within the year can be selected for journeys. Coupled with speed and comfort, as well as attractive decorations and other modern conveniences, effective air conditioning adds another feature to the long list of *Asia's* special appointments.

Since Japan fell heir to Russian interests and activities some thirty odd years ago, she has accomplished a great feat in opening a vast, undeveloped, backward country to western civilization, and elevated it to the rank of a modernized industrial nation. Without railroads, such a great achievement is almost impossible. In the development of industry, agriculture, commerce, forestry and others, railroads of Manchuria have played the prominent rôle, for which the South Manchuria Railway Company deserves the major credit. In fact, the South Manchuria Railway lines were the sole arteries of Manchurian transportation, accommodating the endless flow of outgoing and incoming goods, many of which are found in the most remote parts of the world to-day.

Not satisfied with the one-sided development of freight transportation, the South Manchuria Railway Company has done much to promote and facilitate passenger traffic as well. These efforts were well rewarded, for to-day we find Manchuria in possession of an efficient and admirably managed railway system, which ranks quite comfortably with those of the leading countries, including Japan herself.

The inauguration of the *Asia* marked another step toward progress of Manchurian railway industry. Built entirely of native or Japanese material at a low cost of Y.500,000 (considerably cheaper than the new three-car express of similar type operated by the Union Pacific Railway of the United States, whose cost of construction is said to be $200,000), the *Asia* is also the cheapest super-transport in the world, charging only Y.7.50 (first class) for express above the ordinary ticket. Speed, comfort, safety, convenience, and efficiency all in one, the super-express is a thing to be well proud of. It is not difficult to imagine the feeling of satisfaction and pride of the South Manchuria Railway authorities, as well as of those who fortunately witnessed the historical event, when, on October 22, 1934, the majestic *Asia* triumphantly and gracefully glided alongside its platform in Hsinking for the first time, heralding the dawn of a brighter super-express age in the Far East.

Through dust and rain, wind and storm, the *Asia* can be seen each day, speeding away over Manchuria's endless fields of kaoliang, as if to build each time, another block of the monument dedicated to commemorate the immortal accomplishments and bitter sacrifices made by Japanese predecessors of the past in bringing about this glorious age of railways in Manchuria.

Radium Industry on Great Bear Lake in Northern Canada

(Continued from page 70)

and 1922, had yielded one gram per 128 tons at a cost of around $110,000 per gram. The best ore from the Belgian Congo yielded one gram per ten tons, which dropped in recent years to one gram per 30 or 40 tons. When the Belgian output controlled the world price, radium cost $70,000 per gram.

Gilbert La Bine applied to the Canadian Mines Department for a method of reducing his ore. An unsuccessful attempt was made to obtain information from Belgium. Then the research facilities of the Department were called upon and a new process was developed. A refinery was built at Port Hope, Ontario, where acids were available for the twenty-two stages of precipitation of the radium salts which are necessary to produce commercially-pure radium bromide. Canada recently celebrated production of its first ounce of radium, produced between 1933 and November 16, 1936. The refinery now has a capacity of 3½ grams per month and soon expects to triple its production.

The concentrator at the mines was built under the severe conditions imposed by the Arctic. In addition to the problems of navigation on a normally frozen lake, frost penetrates the ground to a depth of 340 feet below the level of the surface of the lake. Water pipes must be run above ground and insulated or they will freeze even in summer. Telegraph poles cannot be set in this region because earth, removed from the post holes, thaws and then freezes again when replaced with the poles, pushing the poles up. Nevertheless, the plant of 75 tons per day capacity was built and is quite satisfactory.

Concentrated pitchblende is packed in bags, valued at $75 each, and shipped 4,000 miles from the Arctic Circle out to the Port Hope refinery by the same route that the boilers went in. As a result of the exploration of the Canadian North West, the price of radium has now been reduced to $25,000 per gram and, once again, modern scientific methods and research have produced a lasting benefit to society.

Tunnel Driving in the Philippines

(Continued from page 67)

Mill site to the tunnel site. This road clings to the sides of the steepest mountains in the world. Almost every rain, and it rains every day, will bring down one or more slides. This keeps a crew of men and a tractor busy full time to keep the road in shape so that supplies may be taken to the tunnel.

The records show that an average of 661 man shifts were chargeable to outside work which is classified under general overhead. This does not include the steel sharpening crew, compressor men and others whose time is charged to the tunnel itself.

In the tunnel, a total of 2,182 man shifts were charged in June and 2,496 in July. This includes all tunnel workers, including track crew, electricians, motormen, machine men, chuck tenders, etc.

An interesting comparison may be had in reducing these figures to man shifts per foot, as follows :—

	June	*July*
Direct Charges	2.00	1.88
Direct and Indirect	2.62	2.37

The Palidan Suyoc Deep Level Tunnel is the first, though probably not the last, drain tunnel to be driven in the Philippines using modern methods and equipment. In spite of the obstacles, natural and human, the tunnel has, to date, been driven at a greater rate of speed and at lower cost than Philippine mining men had thought possible.

The Progress of Irrigation in North China

By O. J. TODD, Secretary of the Association of Chinese and American Engineers in Civil Engineering

CHINA'S North-west, including the provinces of Kansu, Ninghsia, Shansi, Shensi, and Suiyuan is frequently visited by disaster in the form of a prolonged drought. Ninghsia has garden lands close to its provincial capital where river bottoms have been irrigated for many centuries by the water of the Yellow River, and Suiyuan has had a very crude irrigation system in the Haotao region near the Ninghsia-Suiyuan border, where the Yellow River is also the source of supply. Nevertheless that river has not been utilized to its fullest extent. Similarly in Shansi on the Taiyuan plain there is an archaic system for irrigating lands from the Fen Ho, but the system needs many improvements before the term "water conservancy" in a modern sense can be applied to that river. Likewise the King Ho, the Lo Ho, and the Wei Ho in Shensi Province were not utilized to any considerable degree until recently, although for over 2,000 years the King Ho had been drawn upon to some extent to water the Wei Pei plain lying north of the Wei Ho.

Within the past few years considerable headway has been made towards introducing Western methods in order to get the most economical use of the water, as the adjoining country is dependent upon these areas for better and steadier crop production. Recent studies of climatologists and geologists have produced some evidence that China's North-west is becoming drier at a rate more rapid than other sections of the country. Drifting sands from the Gobi Desert on the north-west are burying farm lands in northern Kansu that formerly produced good grain crops. The Ordos region, immediately north of Shensi, between the Great Wall and the Yellow River, is now a country of sand dunes, although less than a thousand years ago farming communities were situated there. Relics of the Nestorian Christians and the Scythian settlements are found in the shifting sands that now cover the area. Unless rainfall is supplemented by other sources of water supply for growing grain, constantly recurring drought famines must be expected.

Unfortunately China's North-west, for topographical as well as for hydrological reasons, does not lend itself readily to many large-scale irrigation developments. Heretofore only small projects had been carried out, bordering the larger streams or utilizing streams and springs of very limited capacities. But during the past seven or eight years a new movement has been under way to develop larger projects and more thoroughly conserve available flow in the principal streams. Of these larger projects four are very important and have been carried well along towards completion. These are the Saratsi in Suiyuan Province, and the Wei Pei, Lo Ho, and Wei Ho in Shensi Province. The Wei Pei Project has been in full operation for the past year.

Saratsi Project Utilizes Flat Gradients

The Saratsi Project utilizes the Yellow River for its supply at a point ten miles below the western terminus of the Peiping-Suiyuan Railway, 450 miles north-west of Peiping. The main canal, which has a bed 60-ft. wide, extends to the east for over 40 miles. The Yellow River flows in a south-western direction at this point, thus making a triangular area to be served by the canal system. Main laterals, leading off at three-mile intervals, extend to the south nearly to the river.

This region, known as the Saratsi plain, is so flat that the gradient of the main canal had to be estabiished at 1:8,300. With silt-laden water there will be a cleaning problem each year, but fortunately the maximum silt content at the intake of the canal has been found to be less than four per cent by weight at flood time and less than one per cent in ordinary stages of flow (this contrasts sharply with conditions on the other canal systems to be discussed later). Experimental irrigation carried on in 1935 and 1936 (before this project was completed), indicated that, in the early spring when the ice jams break, the fairly silt-free water will help to clear out some of the silt that is deposited in the autumn months.

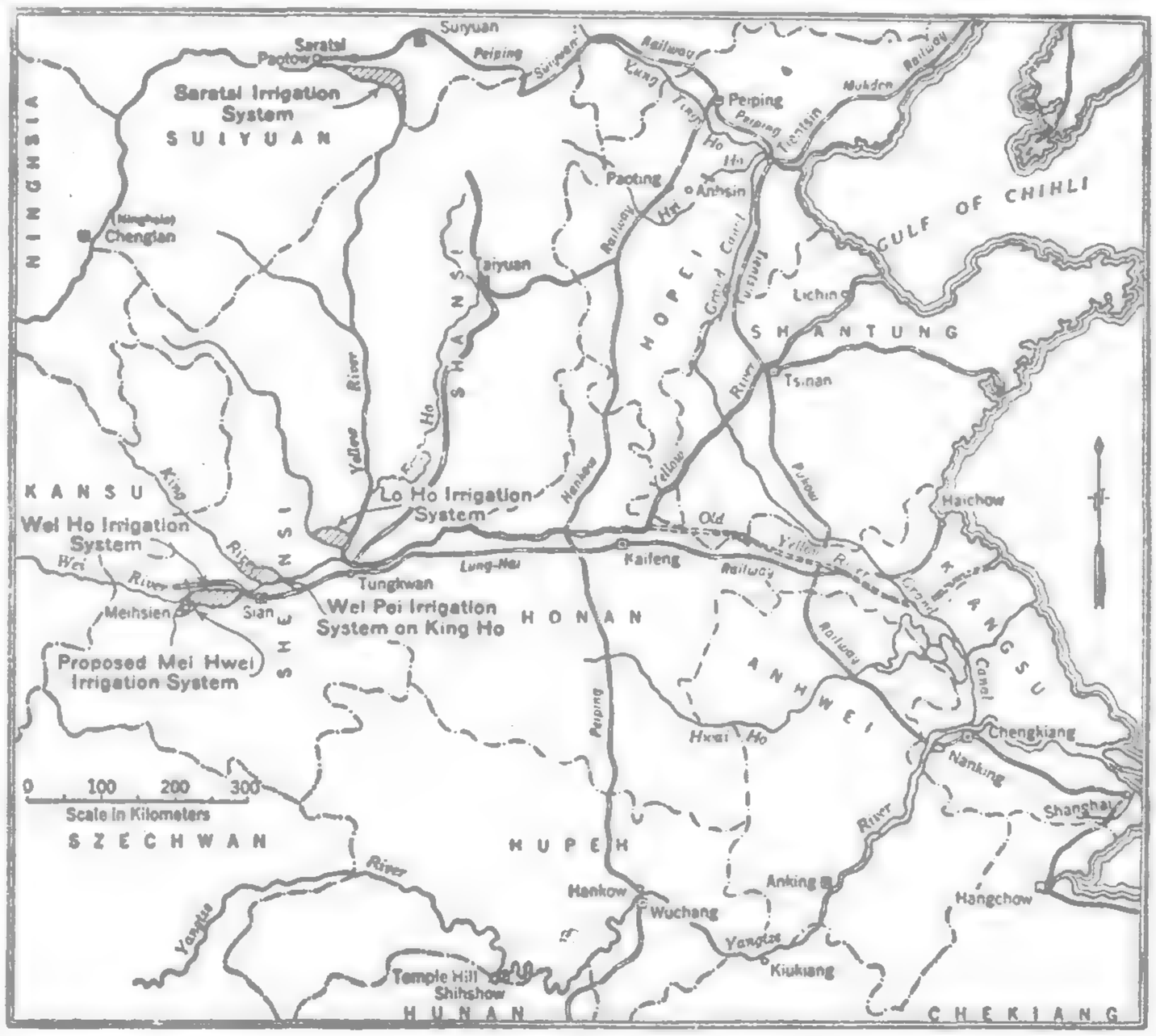
This entire region is one of short summers and sparse rainfall, where agriculture without irrigation is as hazardous as in much of the United States just east of the Rocky Mountains, and it will therefore never be very densely populated. But where irrigation is moderately successful, an outlet will be furnished for some of the surplus population of the Shantung and Hopei plains.

Private enterprise would not have ventured to try to solve this problem, but the severe drought famine of 1928-1929 led a semi-American philanthropic group to bring in funds which made it possible to proceed with the undertaking. Because of insufficient financing, the project has never been entirely completed, although for the past two years it has been in partial operation.

Interesting features of the project are the lack of any means for storing floodwaters and the difficulty of providing gravity flow over the entire area to be served (pumping will be too expensive until the population has been multiplied many times). Most of the irrigating must be done in the autumn right up to freezing time, the fields remaining soaked until spring, as the rainfall occurs chiefly in July and August.

The crops usually raised in this region are millet, oats, wheat, flax, beans, hemp, and kaoliang. It is not yet practicable to introduce sugar-beet growing, and the project is too far north for successful cotton-growing. But the water supply from this canal system will so supplement the ordinary rainfall as to insure a far greater regularity in staple crops than has been possible before. That is what Suiyuan needs at this stage of its development.

Sufficient structures, including masonry headgates, check gates, lateral headgates, and wooden bridges, have been built in the Saratsi Project to make it meet the requirements of the community. Sublaterals will be dug by the farmers with partial aid from the management of the project, and a system of drainage ditches will follow. The project will be improved as population comes in, since there is no rich Uncle



Sam in China to spend even as much as $10,000,000 on a single project.

Reconstructing the Wei Pei System

In view of its long history and its location near an important political center of antiquity, the Wei Pei Project is perhaps the most interesting of the four discussed. This project is located in central Shensi, to the north of Sian. Here much of the surrounding country is rolling or mountainous, but the Wei Pei plain with its several terraces constitutes an area of nearly a million acres of good farm land, and has been known for centuries as the "granary of Shensi." Because of its fertility and extent, the early Chinese made the plain of Wei Pei their first center of civilization.

Coming out of a rocky gorge into the Wei Pei plain from the north-west, the King River joins the Wei River on the plain twenty miles farther east. The King River has been tapped for irrigation purposes at various periods since the first irrigation system was built in 240 B.C. to insure this farming district against drought famine.

The canal system of 240 B.C., constructed a few miles below the mouth of the rocky gorge, was neglected until it became almost useless, and in 96 B.C. a new canal system was built. Through the following centuries this was succeeded by several similar projects, the intake being moved a little farther upstream each time, until finally the rocky canyon was reached. But no adequate headworks were ever installed, so that difficulties occurred both with the floods and with their tremendous mud loads. Cleaning the mud from the main canal became a very expensive operation as the dumps along the banks rose higher. As a result the river-intake canal was closed about 300 years ago, and the flow from springs, entering the canal in its upper section, became the sole supply for irrigation.

After the severe drought of 1920-1921, the Shensi authorities were urged to reconstruct this ancient canal system on more modern lines, with a view to using the available flow of the King River to its maximum capacity. Plans were adopted in 1930 for constructing the new Wei Pei irrigation system. As early as 1924, I had been called in to visit the project as a consultant, but it was six years before I returned supported with adequate funds to go forward with the work. A new drought, occurring in 1928-1929, had in the meantime warranted the granting of funds both by famine-prevention agencies and by the local provincial government. Work was begun in December, 1930, and completed in 1935. The project irrigates 100,000 acres of the Wei Pei plain.

A masonry overflow dam 215-ft. long was built in the canyon to divert the flow through a tunnel 1,300-ft. long in limestone rock. A portable air-compressor from America aided the hand-drilling here. A mile of the canal below the tunnel was cut out of rock on the hillside and built to carry 565 cu. ft. per sec., which was the normal flow designed for. Below this an open-cut canal 3.85 mi. long was cut through soil, gravel, and conglomerate. Eleven bridges of stone masonry and concrete were built to carry mud-charged waters over the canal.

Practically all this work was executed by hand methods, employing a force of 5,000 men during the most active months. The only equipment used was the air-compressor with the accompanying drill equipment and a small pumping unit. The stretches of open-cut work and short tunnels in the main canal's one mile of rock section were all done by hand, the workers being brought in from as far as Kalgan, where they had worked on the Peiping-Suiyuan Railway.

In order to bring in the air-compressor a distance of 180 miles from the terminus of the Lung-Hai Railway, a special road had to be built over the last 30 miles. The only other machines more complicated than a wheelbarrow were the eight h.p. kerosene engine and the small centrifugal pump used at the dam site on foundation work. All concrete was mixed by hand.

Studies of the King River showed a very low flow for short periods during the months of January and June, with a minimum flow of 250 cu. ft. per sec. The maximum flow for rare periods has been estimated at 550,000 cu. ft. per sec. On the main river and most of its branches storage is impracticable because of the very heavy silt loads in flood time. Circumstances seemed to warrant the building of tunnels and main canal to carry 565 cu. ft. (16 cu. m.) per sec., which is about ten times that provided for in the old system for spring water feed alone. The watershed above the intake has an area of 16,000 sq. miles, approximately, and the run off is inclined to be very rapid following heavy showers.

In serving about 100,000 acres by this system, which provides a maximum flow of 565 cu. ft. per sec., an allowance of 4-in. of water per month can be made during much of the growing season, but during short periods in the early summer the entire normal flow of the King River may drop to 40 per cent of the canal's capacity. From October to April the flow of the river is generally greater than the capacity of the main canal, and then the water is practically clear. When turbidity is great, in extreme flood in July and August, the headgates must be closed for short periods, or sluice gates opened in the upper rock section to prevent undue silting. Mud loads of nearly 50 per cent by weight have been measured during freshets. Under these circumstances a skimming weir was considered of little value. In actual practice, water carrying a mud load up to 20 per cent has been put through the canal system and onto the land, but this is not recommended. However, a five per cent load may be carried safely enough.

Wei Pei Diversion Dam and Intake Structures

The diversion dam is a low concrete overflow structure designed to pass a head of 50-ft. of floodwater. It has a crest length of 215 ft., is 30-ft. high in maximum section, and has a top width of 16-ft. Near the intake end, two sluice openings, each 13-ft. wide and 10-ft. deep, equipped with stop-log timbers, were provided for flushing the mud through. Later, however, the Shensi Conservancy Bureau reduced these openings to one that is nearly 7-ft. wide by 7-ft. deep.

Three headgates 5.75-ft. by 4.92-ft., are used to admit the water into the tunnel, which leads under a point of rock to the open-cut main canal below the dam. Hand-operated steel gates are installed in a concrete structure. These gates, which slide against bronze plates, are designed to close the openings tightly, as it is necessary to cut off all flow into the canal system when the silt load is great.

The tunnel section is unlined and has a cross-section of 160 sq. ft. Compared with modern work in the United States it is of little significance, but it was pioneer work of its kind in Shensi. In the mile of open-cut main canal in rock immediately beyond the tunnel, 26,000 cu. yd. of rock was removed by hand, drilling and blasting being done with local black powder.

Where a cut of 70-ft. was required in the foothill section, side slopes of 10 on 1 were used down to berms 6-ft. in width, 10-ft. above the canal bed. The canal has a bottom width of 20-ft. with side slopes of 1 on 1 up to the berm. Later the upper side slopes were flattened to 5 on 1 where the soil was not pure loess and sliding had started. The longitudinal slope of the bed was 1 to 2,133. The earthwork in this earth section totalled 1,000,000 cu. yd.

The method used for moving this material from the deep cut by hand may be of interest. For the first 20-ft. of depth, all the earth was carried out in baskets suspended from the native carrying pole, borne on the right shoulder of the laborer, the total load per trip in the two baskets being from 100 to 125 lb. This load is carried up a sloping path or a set of steps cut in the earth parallel to the edge of the main cutting. When depths exceed 20-ft., tripods with pulleys are installed on top of the bank, near the edge of the cut, and a guide rope is anchored in the canal excavation. A basket carrying a 60 lb. load is then hooked over the guide rope and hauled up by another rope running over the pulley on the tripod above, the power being furnished by four men pulling on the other end of the rope. This is an old Shensi device for cleaning canals in deep cuts.

In recent years ordinary labor in this part of Shensi has been paid from 8 to 10 c. in U.S. currency per day of ten working hours. This rate has been increased somewhat in the past two years. On the Wei Pei job average excavation costs, including deep cutting to a depth of 70-ft., were 6 c. per cu. yd. in U.S. currency. Rock workers, carpenters, and stone masons average about 20 c. in U.S. currency per day. Since large numbers of day laborers are always difficult to handle efficiently, both rock and earth excavation is let out on a unit basis to gangs of 30 to 50 men.

The Shensi Conservancy Bureau has made numerous improvements and extensions since the work was begun late in 1930, so that the project now represents an expenditure of $500,000 in U.S. currency. To China this is a great sum to put into one irrigation system. The system functions well for 100,000 acres of good farm land, which has tripled in value since the new work was initiated.

Wheat and cotton are the staple crops, and various other grains are also grown.

Tunnels and Aqueducts Required on the Lo Ho

Results from the modernized Wei Pei Project were so satisfactory that the Shensi Provincial Government began surveys for other near-by projects. In 1933 studies were made along the Lo Ho, a river rising in north-central Shensi, and flowing south-east into the Yellow River just above the mouth of the Wei. This entire work was under the direction of local Chinese engineers, and both provincial and national governments participated in the financing. Construction began early in 1934 and will be completed in the summer of 1937.

This project, similar to the Wei Pei system, takes the ordinary flow of the river whose adjacent lands it will irrigate. The Lo Ho is tapped in a gorge where a good rock foundation permitted the construction of a masonry dam. The dam diverts flow into tunnels and expensive aqueducts, which extend through rough country before reaching the plains to be served. The tunneling problems were very difficult, on account of the necessity for advancing the headings against running mud without the use of metal shields. The tunnels, lined throughout with cut-limestone masonry, have a total length of 16,000-ft. and the two reinforced aqueducts together, about 650-ft.

In times of heavy rains the Lo Ho has a mud content similar to that of the Wei Ho. Its watershed, barren of trees, has an area of nearly 10,000 sq. mi. At normal times the flow of this river is comparatively clear, the average discharge being somewhat less than 500 cu. ft. per sec. The minimum flow is about 180 cu. ft. per sec., and for design an extreme maximum of 125,000 cu. ft. per sec. was assumed. The flood of 1935 showed a maximum silt content of 50 per cent by weight at the intake, while a sample taken in 1934 gave as high as 63 per cent solids by weight.

This canal system has a total length of 13.2 mi. for the main canal and 48.9 mi. for the several branch canals and main laterals below the last tunnel. All necessary structures have been built of stone and concrete, including regulator, waste gates, bridges, and drops. The two high aqueducts, however, are the most picturesque appurtenances of the system and evidence quite as much skill in construction as the arch masonry dam. This dam has a height of 53-ft., a crest length of 443-ft., a crown width of 16 ft., and a bottom width of 69-ft.

Approximately 80,000 acres of grain and cotton land along the lower Lo Ho will be served by the project. The total cost will be a little over $500,000 in U.S. currency and will be gradually paid for by moderate water rates. Its first real test will come in 1938.

Wei Ho System Indicates Construction Progress

By far the largest river flowing out of Shensi Province is the Wei Ho, which contributes to the Yellow River the greatest mud load of all the latter's tributaries. The Wei, which rises in Kansu Province, is an important stream even before the King Ho empties into it 50 miles above its mouth.

The Wei Ho Project was dedicated by the Shensi Conservancy Bureau after completion of the first stage at the close of 1936. This project will irrigate approximately 120,000 acres on the north bank of the Wei. In the past this land has produced but one crop a year, and because of extreme drought has had complete crop failures once or twice in every decade. With irrigation it is hoped to grow two crops annually as a rule. Like the Wei Pei region, it is adapted to the growing of cotton and grains such as wheat and millet.

Diversion into this canal system is made at a point nearly 70 miles west of Sian by means of a low overflow dam, 1,640-ft. wide and 10.5-ft. high above the clay-gravel streambed. This dam is of concrete with ashlar facing and with two rows of interlocking steel sheet-piling as a protection against percolation. It has a crown width of 6.5-ft. and a base width of 26-ft. The depth of flow over the dam should never exceed 12-ft. The apron of the dam is made of cubical wire cages 3.3-ft. on each edge and filled with rubble. The lower end of this wall is protected by a concrete wall 3.3-ft. thick.

The regulator structure, located immediately above the dam, has six openings, each 5.7-ft. wide by 6.5-ft. high at the head of the main canal. This structure and all drops, bridges, and the one aqueduct are built of concrete. Combined with the regulator or headgate structure are sluice gates to wash through mud deposits, for the Wei has a heavy silt load comparable to that found in the King or the Lo.

The main canal is 25 miles long. There are no tunnels, and most of the excavation is in cut of moderate depth. The one aqueduct required for crossing a small stream is 236-ft. long. The drops and bridges are of standard design and up to date. Altogether this is the best-built irrigation project yet constructed in China from the standpoint of structures. It represents the progress that has been made in the past five years in this region and the willingness of the provincial government to help finance engineering work in an ample way. Moreover, the farmers are convinced that they will gain through irrigation more than they will be assessed in water rates.

Other Irrigation Projects

Just upstream and on the opposite bank of the river from the Wei Ho Project, a small tributary is about to be tapped to feed another small canal system which will irrigate 30,000 acres of Wei Valley land. The cost of this project, the Mei Hwei, is estimated at $150,000 in U.S. currency. When it is completed, most of the land that can be irrigated by direct diversion from the Wei, King, and Lo Rivers will be served. Other lands in this central Shensi territory can only be irrigated by more expensive methods.

In Shansi Province, however, there is much that can be done to extend the areas of irrigated lands along the Fen Ho, the chief river. Three small pumping stations have already been built on the lower Fen Ho where the lift will not exceed 30-ft. Also, in the main Taiyuan plain, the Fen Ho diversion works have been improved somewhat by the construction of two masonry dams with many gates to pass floodwaters. But there is need for storage of the winter flow. Although comparatively free from silt, this flow is now wasted to a large degree.

Studies made in 1933 and 1934 by the writer were the basis of a printed report to the governor of Shansi on this problem of Fen Ho conservancy. The total estimated cost of the improvements deemed necessary for flood protection and water conservation on that river amounted to approximately $4,000,000 in U.S. currency. This is one of the projects that await capital for their execution. It is the next logical water conservancy undertaking for North China, since the Shensi work is now nearly completed. Though returns on the investment may be slower from such a project than from a railway built through densely settled country, it is equally sound where government functions justly and is stable.

Soviet Fleet Stronger

Declaring that the Soviet Union's coastal fortifications are fast becoming as impregnable as the land borders, the Krasnaya Zvezda, organ of the Commissariat for Defense, revealed recently that an "astounding enlargement" of the Soviet Baltic, Pacific and Black Sea fleets has been carried out to perfect the country's defense system.

Although the report lacked actual details of the fleet expansion program, the journal asserted that the ships are "lavishly equipped, embodying the most modern technique, with excellent guns and their performance has proved their quality in storms and bad winter weather."

The journal paid particular attention to the facilities of the northern Soviet fleet base at Murmansk, where smaller vessels can pass from the Baltic Sea to the White Sea via the canal instead of going through a long voyage around Scandinavia.

The journal adds that there are many "remarkable ships now appearing on the Pacific coast," probably referring to the large fleet of the new whale-type submarines being transported to and reassembled at Vladivostok.

Mention is made of strong coastal fortifications on the "sea boundaries," although no details are disclosed of the positions of the fortresses.

Why We Are Exploring the North Pole

By O. Y. SCHMIDT, in Pravda, May 22, 1937

In the North Polar area, in the central polar basin there is no land, but a deep ocean almost entirely covered by ice, which is constantly drifting. Assuming that a man stepped on to the north pole, he would instantly be carried away from this spot.

To determine the location of the North Pole one must measure the height of the sun or other heavenly bodies above the horizon and make corresponding astronomical calculations. While these calculations are being made the drifting ice will have moved the observer to a new point across the pole.

Obviously, the essential aim is not to reach a definite spot, but to penetrate into the central polar basin as a whole and in the region immediately surrounding the North Pole.

The daring expeditions which have been made in the past did not and could not furnish weighty scientific evidence. Although the North Pole has been reached, the central polar basin remains unexplored. No attempts were even made to make practical use of the scientific data obtained by explorations of the polar regions.

Expedition camp at North Pole drifting station

Soviet exploration of the Arctic was based on a unity of theory and practice, in which scientific surveys and practical application go hand in hand. Our second principle was to conduct scientific observations constantly and thoroughly from day to day and not in a desultory fashion by short-lived expeditions.

Following these principles our country has covered the islands and coast line of the Soviet parts of the Arctic Ocean with a network of polar stations which are constantly keeping observations on the weather, the state of the ice, the chemical and physical properties of the sea and so on. These polar stations have provided us with the fundamentals for a practical mastery of navigation in the Arctic Ocean.

This is the only practicable method of studying the problem of polar conquest.

We would not have aspired to reach the North Pole had we not known that serious scientific investigations had to be carried out there which were useful and necessary for our country's development. Isolated flights to the pole could not have satisfied us.

Following our well-tried methods we set up in the central polar basin a polar station, i.e., a constantly working scientific observatory linked with a sufficiently powerful wireless station.

A feature of our method of treating the polar problem is that we not only visited this region but entrenched ourselves there in order to make practical use of the observations collected.

What do we know and not know about the North Pole ?

After Nansen, Peary and Amundsen and other polar explorers we knew that around the North Pole there was no land but sea. We knew that the sea was covered by ice. We knew, of course, that it was cold there. And that is about all. But we want to know much more than that.

We want definitely to know the weather around the pole, its variability and seasonal changes. We want to know the atmospheric pressure and changes no less than the temperature. By aid of pilot balloons we want to study these and other atmospheric phenomena not only on the surface of the land but throughout the whole atmosphere.

Systematic observations over weather factors are both of theoretical and immense practical interest. It is known that the movement of cold masses of air prevailing in the atmosphere above the polar basin essentially affects the climate in Europe and Asia, including that of the Soviet Union.

It is an old maxim that " the weather is made in the North." And yet our information about the weather is culled merely on the margin of the North at our polar stations and we still know nothing of what is going on in the central polar basin. Our theoretical surmises about the so-called " cold air lid " will be verified and exactly defined only as a result of the work of the station in the region of the North Pole. Our weather forecast routine will be materially facilitated and synoptists will receive reports from a very important region—the central polar basin.

Another sphere of observation is associated with navigation. After the drift of the *Fram* we know that the ice generally drifts from east to west. We know very little, however, of the details of this drift and particularly to what extent it prevails in the region of the North Pole itself. Except for casual information we also know nothing about the depth of the Arctic Ocean in its central part.

It is very important to solve the problem about the movements of the lower and middle strata of the water and whence they originate—in the eastern part of the Arctic Ocean or the Atlantic. By means of chemical tests and physical observations we shall be able to ascertain the processes

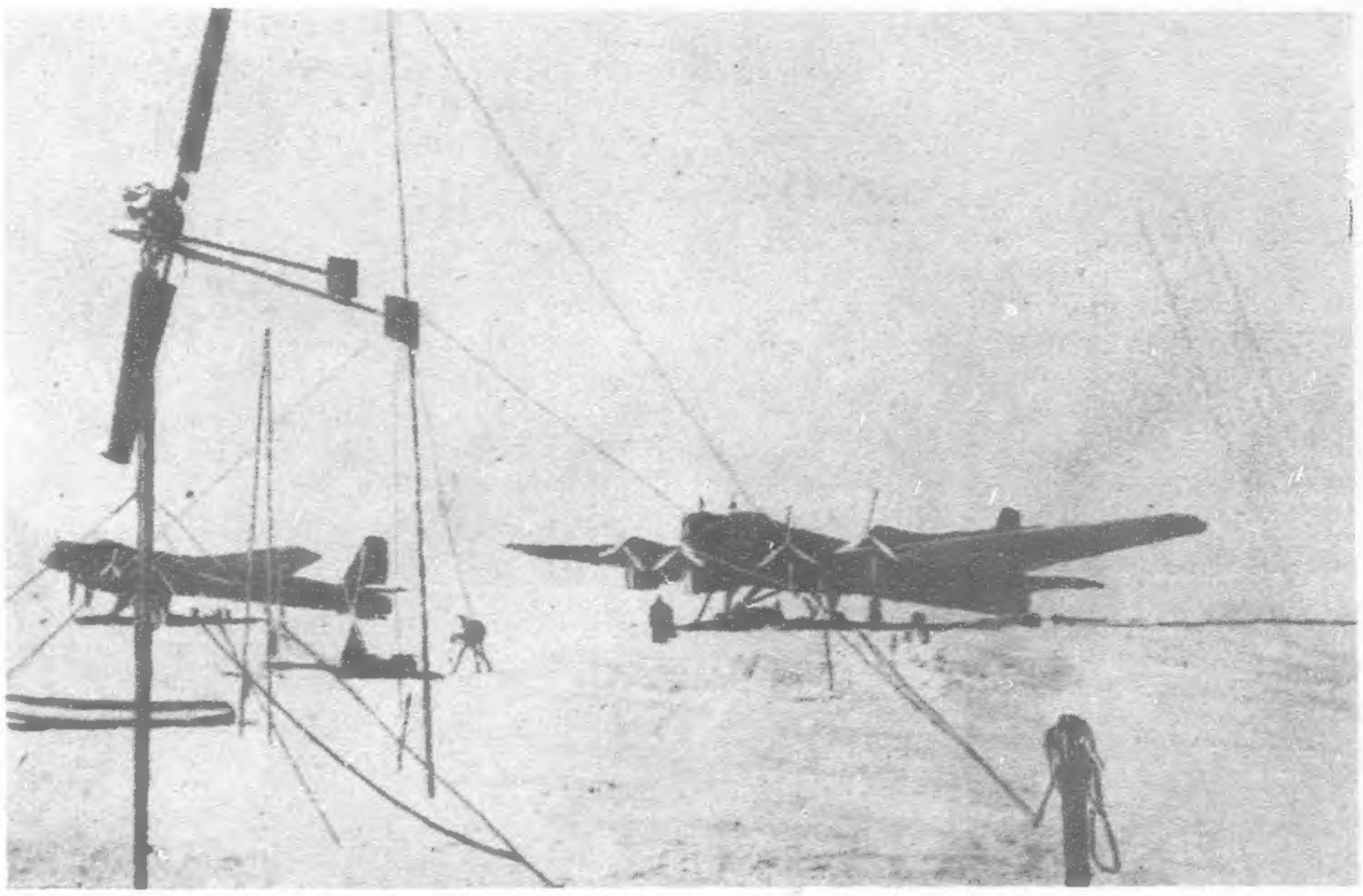
O. Y. Schmidt, chief of the expedition at the North Pole drifting station

EDITORS'S NOTE : The above article was written before the non-stop flights Moscow—U.S.A. via the North Pole were successfully accomplished by Soviet fliers.

occurring in the depths of the water. Biological studies will reveal how far life is extant in these high latitudes.

Observations of the sea and ice will enrich our knowledge concerning the circulation of the ice in the Arctic Ocean, which in turn is associated with navigation problems along the great arctic route. Knowing the conditions prevailing in the center of the ocean we may discover the laws which regulate the movement of the ice near the shores. The practical significance of these investigations from the point of view of arctic navigation is very great indeed.

Regular study of magnetic phenomena is another extremely interesting problem. We still do not know anything about the direction and force of terrestrial magnetism in the region of the North Pole. Apart from its theoretical interest a knowledge of these phenomena would fill a serious gap in our magnetic charts. Future pilots of trans-polar 'planes would receive proper rectification of compass readings. Unless one has a knowledge of magnetic peculiarities in this region the compass is useless as an aid to find one's bearings and may, on the contrary, lead to disaster.



'Planes at North Pole drifting station

The scientific station in the polar basin will help to solve not a few geophysical problems, both theoretical and practical (investigation of the diffusion of radio waves, for example).

These tasks alone would be sufficient justification for the expenditure of effort and money to which our country has committed itself in the sphere of polar activities. There is another vital problem, however, which should be added: by establishing a station in the region of the North Pole we have made a very important step towards ensuring the safety of aeronautics in the polar regions.

There is not the slightest doubt that the idea of accomplishing trans-polar flights from Europe to America is now capable of being brought to fruition. The establishment of regular communication between Europe and America by the shortest route via the central polar basin will eventually become a possibility provided there is a base in the region of the Pole.

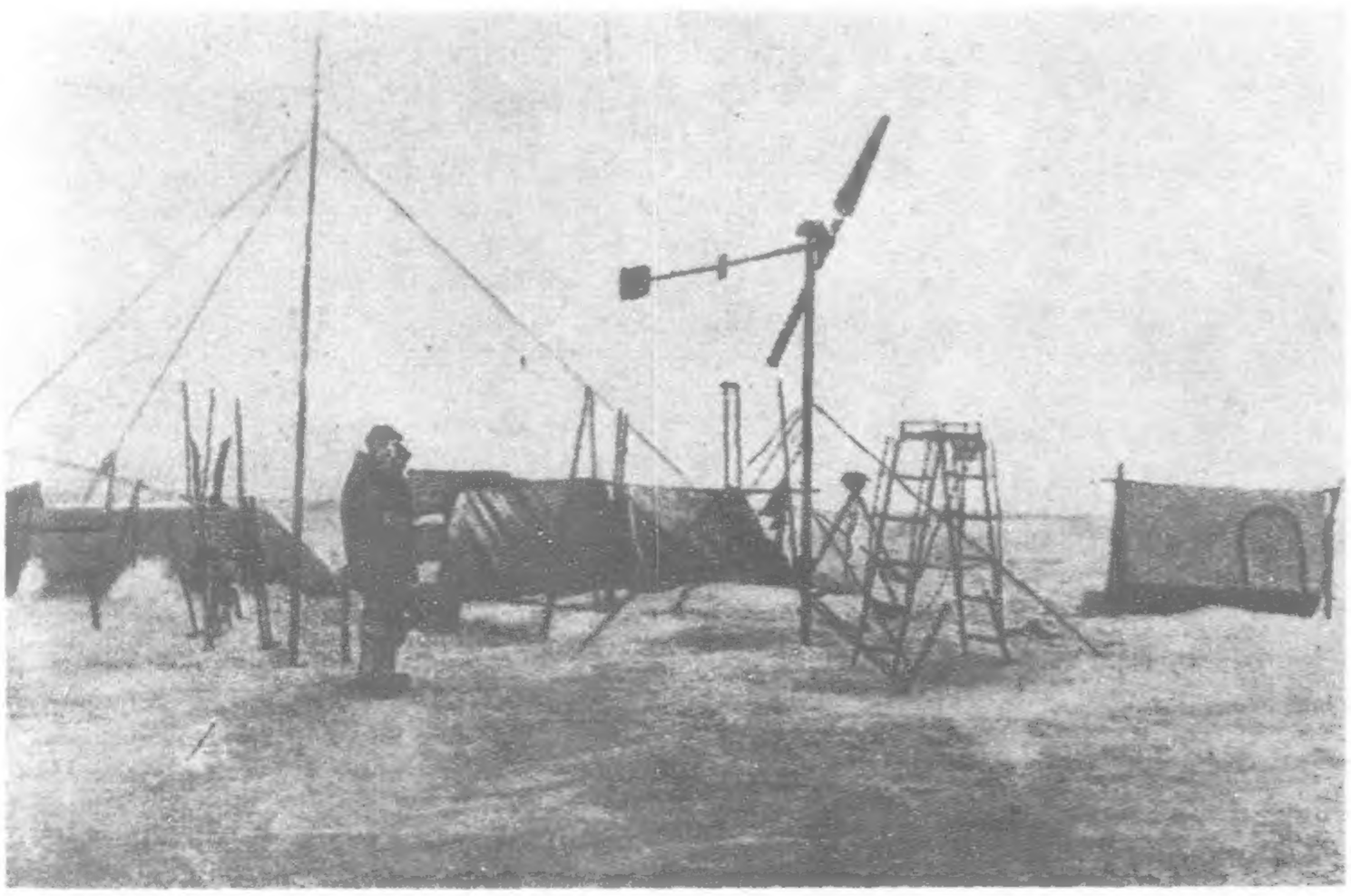
Airmen flying across the central polar basin will have the services of a vital station which will furnish them with reports on the weather and will enable them to take their bearings by wireless signals from the station on the drifting ice field. It is not improbable that emergency airdromes will, in time, be created in the polar basin which will make this passage safe for flying.

These, then, are the reasons why we have set up a station in the region of the North Pole.

I do not say "a station at the North Pole," because the drifting ice field, as I have already mentioned, will be constantly changing its position. There is no harm in that. The station's drift will, on the contrary, greatly widen the field of its scientific observations. It will be a center of stationary and constant observations and at the same time an expedition on the move.

The establishment of a polar station in the Extreme North of the globe in the region of the north pole is the consummation of many years of study and exploration by Soviet men. This unprecedented enterprise has materialized as a result of the most careful attention and solicitude which is extended in the Soviet Union to the work of polar explorers.

The landing of a flying expedition at the North Pole and the organization there of a scientific outpost is additional proof of socialism's success in accomplishing what capitalism has failed to do.



Tents and meteorological apparatus at North Pole drifting station

Japan Plans Domestic Products Exhibition

The "Grand Fair of Domestic Products," which is scheduled to be held in Tokyo between March 20 and May 19 next year under the auspices of the Japan Quality-Products Manufacturers Association, will be supported by the Navy, War and Commerce and Industry Ministries, business organizations and the Japan Broadcasting Association with Y.500,000, *Domei* says.

The object of the exhibition is to contribute to patriotism, spiritual mobilization and national productive expansion. Because of the China incident, four other fairs scheduled for next year at Sendai, Kyoto, Niigata, and Kofu have been cancelled.

The exhibition buildings will include ones for textiles, chemicals, machinery, electrical, food and general goods, the world as a whole, Manchoukuo, the navy, army, aviation, war spoils, North China, Shanghai and Inner Mongolia.

Engineering Notes

MINING

SOVIET GOLD.—Exceeding the preceding year by about 50 per cent, the gold produced in the first five months of 1937 by the Manchuria Gold Mining Company has been valued at Y.3,767,000. Total production for the year is expected to reach Y.15,000,000.

TIN MINING.—Drought in the Federated Malay States has had a serious effect on tin mining, many smaller producers being now faced with the necessity of selling their current quotas owing to inability to produce, and many of the gravel-pump mines having ceased work entirely.

OIL FROM COAL.—South Manchuria Railway Company is planning to double the production of shale oil at its Fushun collieries. Present yearly output of crude oil is about 150,000 metric tons, and this the company plans to increase to 360,000 metric tons during 1939. Expansion of the plant is to be started immediately and will be completed in two years.

COAL MINING IN MANCHURIA.—The Manchurian Coal Mining Company during the first 11 months of the fiscal year which ended on June 30 last raised 1,964,000 tons of coal, or 275,200 tons more than in the parallel period of the previous fiscal year. Hsian colliery produced 856,900 tons, Holikang colliery 330,200 tons and Peipiao colliery 273,100 tons. A coal-hydrogenation concern has been formed in Manchuria with a capital of Y.50,000,000, of which, Y.17,000,000 is to be subscribed by the Government, Y.17,000,000 by the Japanese Mitsui concern, Y.8,000,000 by the Manchurian Coal Mining Company, Y.5,000,000 by the South Manchurian Railway Company, and Y.3,000,000 by the Manchurian Petroleum Company. An output of 30,000 tons of motor spirit is estimated for 1938 and 300,000 tons for 1939.

IRON PRODUCTION.—Japan expects to increase her iron production from 700,000 to 1,700,000 tons per year by the utilization of the so-called Krupp-Renn patented process for the treatment of low-content iron ores. The sole right to work the patents in Japan and Manchuria was recently acquired from Krupps by an important Japanese industrial combine headed by Mitsubishi Kogyo Kabushiki Kaisha. The processes are first to be applied at the Showa Seiko Sho works. A contract for the supply of plant comprising eight large furnaces has been placed with Fried. Krupp Gruson Werke A.G. at Magdeburg-Buchau by Mitsubishi Shoji Kaisha G.m.b.H., Berlin. The Krupp-Renn process has been in use in Germany for several years at two large ironworks. An essential feature of the process is the use of fine-grain coke or coal as reducer, this enabling the iron to be recovered in the form of large metallic lumps.

BASIC METAL SHORTAGE.—Notwithstanding Malaya is an important producer of iron ore, the main supplies of which come from Johore and Trengganu, there is an acute shortage of basic metals. For any European country to attempt the exportation of ore from Malaya would, it is considered, be uneconomic, consequently production is virtually in the hands of the Japanese who, facing their own steel problem, transport all they can to Japan. In 1932 Japan took from Malaya 689,000 tons. At the end of 1936 this had grown to 1,700,000 tons. To keep this ore in the country and smelt it locally would require the installation of an expensive modern plant, and up to now no enterprise has been bold enough to shoulder such an undertaking. Meantime, according to the *Times of Malaya*, orders placed abroad for basic metals as far back as November last are only just arriving, and supplies continue to be either late or restricted, particularly steel sections, angles, channels and steel joints.—*Eastern Engineering and Commerce.*

WOLFRAM MINING.—Kwangtung interests plan a company to develop wolfram mining in the province. Capitalized at $1,000,000, the company will be financed one-half by the provincial government and one-half by overseas Chinese. With the initial capital provided by the government machinery will be bought. The first mines will be opened in the Chungfa and Yingtak districts.

In view of the intensive demand for wolfram, which became more accentuated after the adoption of the defence program, prices have shown abnormal strength.

With China responsible for about two-thirds of world supplies, and this exclusively mined in the four southern provinces, there is greater danger that supplies may be interfered with by the present extension of hostilities in the south of China.

The high level of prices now ruling may stimulate production in Bolivia, Burma, the Malay States, Portugal, and the United States, though it will be some time before these increased supplies become available.

COMMUNICATIONS

PHONES IN MALAYA.—Malaya is becoming increasingly telephone-conscious, and new lines are daily being installed in Singapore and Johore, under the system operated by the Oriental Telephone and Electric Co.

BRITISH MOTOR CYCLES.—British motor cycles earned conspicuous success in a recent reliability trial organized by the Malayan Automobile Association. The "unlimited capacity" team prize and the award for the fastest time recorded were among the distinctions gained.

FLIGHT TO CEYLON.—Ceylon is to be brought regularly within the Empire Air Service. Plans are being completed for extending to Ceylon the route operating from Karachi to Bombay and Madras. A regular 450-miles extension from Madras will take this service on to Colombo, and passengers as well as mails are to be carried.

AERIAL ROPEWAY.—Messrs. Arnhold & Co., Ltd., Shanghai, have been given a contract to supply an aerial ropeway to convey passengers in carriages up to Kuling, the famous mountain resort, in ten minutes instead of two hours by chair, as at present. The equipment for the ropeway, which is to be ready by the summer of 1938, is being built by Bleicherts, of Germany.

HARBOR DEVELOPMENT.—The most northerly harbor on the Soviet coast of the Far East is to be constructed in the Bay of Providencia. Workers have already arrived at Vladivostok. The new harbor, Moscow expects, will be an important point on the northern waterway from European Russia to the Bering Strait for transportation of troops and material in case of war. In the above connection it is of interest to note that the 5,000 ton Soviet floating dock, which left Odessa on April 9, arrived safely at Sovetskaya Gavan, on the East Siberian Coast, last month.

IMPERIAL AIR SERVICE.—Active preparations continue in organizing the England-India route for the operation of the big flying-boats which will, as soon as the necessary technical equipment is completed, be carrying first-class letter-mails without surcharge on this vital trans-Empire route. In addition to new air-harbors, and an amplified wireless and meteorological organization, a special equipment for night-flying is being provided; while it has now been arranged that a flight shall be carried out to make detailed surveys over the sections of the route lying between Alexandria and Karachi.

CHINESE PICTURE LANGUAGE.—Since passengers patronizing the suburban bus services operated by the Rangoon Electric Supply Co., Ltd., use any of twelve different languages, and a considerable number cannot even read or write, the company's fleet of Leyland buses has been equipped with pictures of animals instead of the usual destination indicators. Each animal, taken from a Chinese gambling game known as "The 36 Animals," is used to indicate a different bus route. An oil-engined Leyland Cub is the latest machine to be added to the fleet, and the particular sign allotted to it is the "Naga," a mythical Burmese super snake.

HULUTAO PORT COMPLETED.—The completion of the port of Hulutao was announced on April 6, by the South Manchuria Railway Company, which had charge of the construction, and its facilities will be opened to shipping within the next few weeks. Construction began in April, 1936. The equipment includes a breakwater and two long piers, built at a cost of Y.16,000,000. The new port will facilitate the handling of the Fushun coal and the general development of south-western Manchoukuo. The building of the harbor was first undertaken by a Netherlands firm in 1930, but was stopped in 1932, with the flight of the "Young Marshal" to Peiping.

MANCHOUKUO AIR TRANSPORT.—The Manchuria Air Transport Co., which enjoys a monopoly of air transportation in that country, was formed in October, 1932. At the present time it is operating fourteen commercial lines, with a total length of 8,170 kms. In addition it sponsors the four lines into North China, with a total length of 1,475 kms. It also operates two military lines, on which ordinary passengers can be carried whenever vacant seats are available. This company, which was financed by the Manchoukuo Government, the South Manchuria Railway Co., and the Sumitomo Co. of Japan, operates a through service with the Japan Air Transportation Co. During nearly four and a half years of operation there have been remarkably few accidents.

BUSSES FOR SHANGHAI.—Fifteen new four-wheeled trolley buses have been ordered from the Associated Equipment Co., Ltd., Southall, by the Shanghai Electric Construction Co., Ltd. The buses will be of the latest design and they are to operate a new route to link the northern part of the Western District with Rue Lafayette and the south-eastern part of the French Concession. The order follows on the satisfactory service given by the 115 A.E.C. trolley-buses already in operation. The 15 new buses will carry the latest refinements and electrical equipment. They will be fitted with pneumatic tyres, six in all, two on the front wheels and four on the back. Inside they will be fitted with white panelling, while the lighting will be of the bulk-head type. Incidentally, it is revealed that the company will be ordering another ten buses immediately